UNCLAS

GEMINI PROPULSION

TECHNICAL REVIEW MEETING

9-12 FEBRUARY 1965

BELL
AEROSYSTEMS
COMPANY
DIVISION OF BELL AEROSPACE CORPORATION
A
textron
COMPANY

GEMINI PROPULSION SYSTEM
MULTI-START ENGINE
BAC MODEL 8247
USAF MODEL XLR 81-BA-13

SYSTEM REQUIREMENTS

		8096	8247
NUMBER OF STARTS	ENGINE (MISSION)	2	15
	ENGINE (NOMINAL)	15	25
	THRUST CHAMBER	25	35
	NOZZLE EXTENSION	2	15
MINIMUM TOTAL IMPULSE		—	17,500 lb-SEC
PROPELLANT UTILIZATION	START lb.	12 OX	6 FUEL
	SHUTDOWN (OX) lb.	35	28
START SYSTEM LOAD & PAD HOLD		DRY	WET
ELECTRICAL CHARACTERISTIC		—	EMI
RELIABILITY DEMONSTRATION @ 90% CONFIDENCE LEVEL		.997	NONE REQ'D

MODEL 8247 ENGINE

DESCRIPTION AND OPERATION

SYSTEM REQUIREMENTS

ENGINE TESTING

DEMONSTRATION

ENGINE XRM1 70 FIRINGS @ 110,000 FT ALT.

ENGINE XRM2 80 FIRINGS

ENGINE XRM3 61 FIRINGS

QUALIFICATION - PFRT

ENGINE S/N 801 36 FIRINGS

WEIGHT	HIGH TEMPERATURE
DRAINAGE	HUMIDITY
VIBRATION	LOW TEMPERATURE
SHOCK	MALFUNCTION
FIXED THRUST CALIB.	DISASSEMBLY & INSPECTION

PFRT PROBLEM AREA

DUAL CHECK VALVE

GAS GENERATOR SOLENOID VALVES

START TANKS

TURBINE PUMP DEVELOPMENT TESTING
MULTIPLE RESTART

MODEL 8247

I EXPLORATORY TESTS

A START TANK SYSTEM - 59 RUNS - 106 STARTS - 1210 SEC.

1. START TRANSIENTS
2. SHUTDOWN TRANSIENTS
3. OXIDIZER CRACKING PRESSURE EFFECT
   - a PROPELLANT PRE-FLOW
   - b PROPELLANT POST FLOW
4. START TANK BLOWDOWN AND RECHARGE
   - a AT HIGH TEMPERATURE
   - b AT LOW TEMPERATURE
5. RESTART AFTER VERY SHORT DURATION RUN
   - a AT AMBIENT TEMPERATURE
   - b AT +10°F TEMPERATURE

B PUMP SUCTION PRESSURE START SYSTEM

39 RUNS - 39 STARTS - 1471 SECONDS

1. ENVIRONMENTAL LIMITS ON START TRANSIENTS
   - a OXIDIZER PUMP SUCTION PRESSURE
   - b FUEL PUMP SUCTION PRESSURE
   - c OXIDIZER PROPELLANT TEMPERATURE
   - d FUEL PROPELLANT TEMPERATURE
   - e HARDWARE TEMPERATURE
   - f TURBINE STATIC FRICTIONAL TORQUE

C CONCLUSION

START TANK SYSTEM MET ALL ASPECTS OF THE MULTIPLE RESTART REQUIREMENTS.

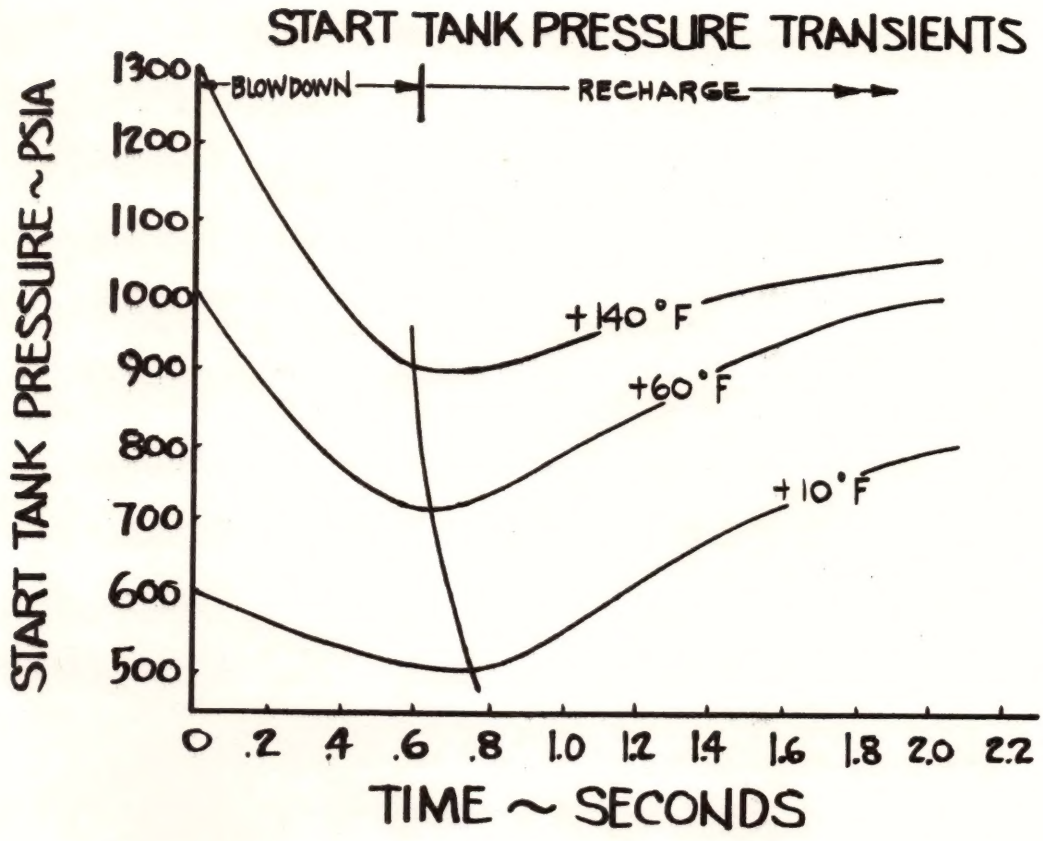
II DEVELOPMENTAL TESTS

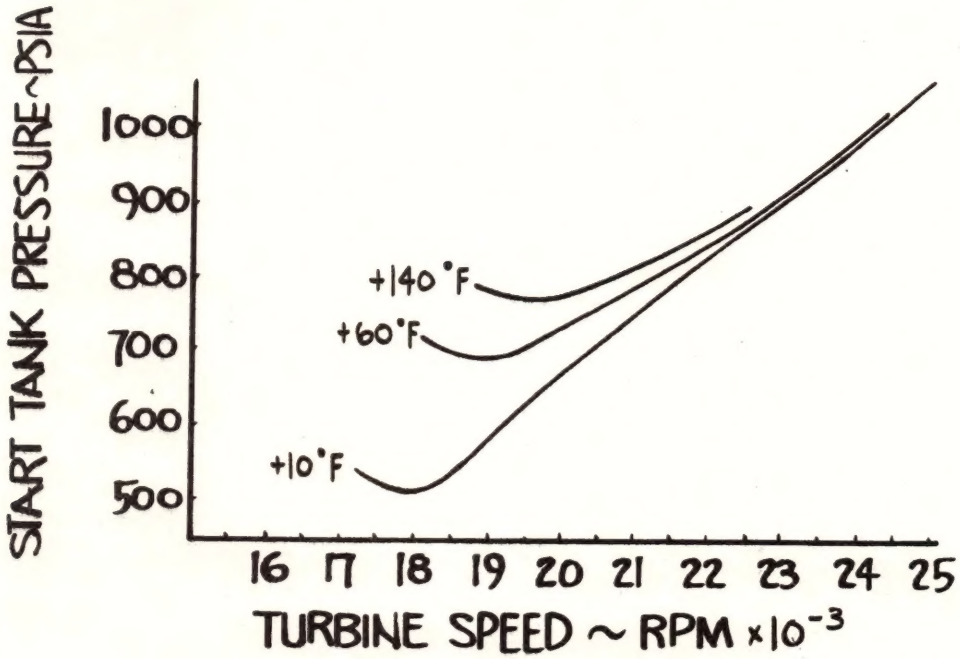
A BOILER PLATE TYPE HARDWARE, 25 RUNS- 49 STARTS- 1876 SEC.

1. START AND SHUTDOWN TRANSIENTS
2. START TANK BLOWDOWN AND RECHARGE
3. MALFUNCTION TESTS
4. GAS ENTRAPMENT IN START TANK SYSTEM

B PROTO TYPE HARDWARE 200 RUNS 453 STARTS 15,422 SEC.

1. FUEL VALVE OPENING EFFECT
2. START AND SHUTDOWN TRANSIENTS
   - a "BIT IMPULSE" DURATION
   - b TEMPERATURE EFFECT
   - c START TANK PROPELLANT LOADING
3. GAS GENERATOR VALVE EVALUATION
4. MALFUNCTION TESTS


START TANK PRESSURE TRANSIENTS
START TANK PRESSURE ~ PSIA
1300
1200
1100
1000
900
800
700
600
500
BLOWDOWN
RECHARGE
+140°F
+60°F
+10°F
0 .2 .4 .6 .8 1.0 1.2 1.4 1.6 1.8 2.0 2.2
TIME ~ SECONDS


START TANK PRESSURE ~ PSIA
1000
900
800
700
600
500
+140°F
+60°F
+10°F
16 17 18 19 20 21 22 23 24 25
TURBINE SPEED ~ RPM x10⁻³

MODEL 8247 START TANK SIZING

A OBJECTIVES

1. TO DETERMINE FUEL AND OXIDIZER START TANK SIZES
2. TO ESTABLISH LOAD CONDITIONS AT 60°F TO SATISFY OPERATION FOR:
   a. TEMPERATURE RANGE OF +10°F TO +140°F
   b. MINIMUM ENGINE IMPULSE OF 16,000 LB-SEC AND STEADY STATE RUN IMPULSE

B VARIANCES CONSIDERED

1. FLIGHT SPEED	±3%
2. LOADING	±2%
3. MAXIMUM PROPELLANT LEAKAGE	$1 IN^3$

C OPERATING SEQUENCE

1. LOAD NOMINAL AT 60°F
2. RUN TO STEADY STATE AT 50°F
3. RUN TO MINIMUM "BIT-IMPULSE" AT +140°F
4. RUN TO STEADY STATE AT -10°F MAXIMUM SPEED
5. CONDITION SYSTEM TO +140°F

THRUST CHAMBER TESTING

THRUST CHAMBER PFRT (8096)

OBJECTIVES

1. DEFINE THRUST VARIATION WITH CHAMBER PRESSURE ($P_c \pm 5\%$ RATED) WITHOUT NOZZLE EXTENSION
2. DEMONSTRATE FIRING OF NOZZLE EXTENSION IN ASPIRATOR DUCT AFTER TEMPERATURE CYCLING

TESTS CONDUCTED

CONDITION	% RATED P_c	Nº TESTS
BASIC CHAMBER	100	2
BASIC CHAMBER	95	2
BASIC CHAMBER	105	2
BASIC CHAMBER PLUS NOZZLE EXTENSION	100	2

RESULTS

1. THRUST vs P_c ESTABLISH = 27.88# F/PSI P_c
2. NO DETRIMENTAL EFFECTS OF TEMPERATURE CYCLING ON A NOZZLE EXTENSION TESTED IN AN ASPIRATOR DUCT.

PRESSURE SWITCH REMOVAL PROGRAM

OBJECTIVE

DEMONSTRATE FUEL LEAD

ANALYSIS

FUEL LEAD OF .16 TO .205 SECONDS

TEST PROGRAM

Nº TESTS	58
Nº CHAMBERS	2

DEMONSTRATED

	FEED PRESSURE	FUEL LEAD RANGE	TEMPERATURE	Nº TESTS
1ST BURN	80-130% RATED	.04 To 1.0	AMB-140°F	31
2ND BURN	RATED (400 PSI)	.10 To .97	-2°F-150°F	14

DEFINED ACCUMULATION EFFECTS OF FUEL LEAD

NONE

Pc OVER SHOOT ON START

	RANGE %
OX LEAD	34 TO 49
1ST BURN FUEL	02 TO 24
2ND BURN FUEL	16 TO 38

ALTITUDE TESTING

AEDC

MODEL 8247 START TANKS

A - COMPONENT REVIEW

1 - THE QUALIFICATION OF THE START TANKS WAS PERFORMED DURING THE FLIGHT VERIFICATION TEST PROGRAM.
THE FVT TESTS WERE:

I STRUCTURAL INTEGRITY (2 SETS OF SHELLS)
SET #1 - AFTER 30 DAY SALT WATER EXPOSURE AT MAXIMUM STRESS.
SET #2 - IN THE "AS RECEIVED" CONDITION.

II DESIGN OBJECTIVES & DYNAMICS (2 SETS OF ASSEMBLIES)

SET #1
a) MALFUNCTION PRESSURES
b) DUTY CYCLES
c) DYNAMICS (MODEL SPEC LEVELS
d) BELLOWS YIELD
e) STRUCTURAL INTEGRITY
f) METALLURGICAL EVALUATION

SET #2
a) SIMULATED SHIPPING PRESSURES TEST
b) DUTY CYCLES (10)
c) BELLOWS LIFE CYCLE
d) STRUCTURAL INTEGRITY
e) METALLURGICAL EVALUATION

III COMPATABILITY
a) OXIDIZER START TANK SYSTEM IN 38 DAY PAD STORAGE TEST
b) OXIDIZER BELLOWS FROM ENGINE #802

IV DEVELOPMENT PROBLEMS & CORRECTIVE ACTION

D.P. - BELLOWS STICKING OR HANGING UP

C.A.
- a) IMPROVED SURFACE FINISHES
- b) CONFIGURATION CHANGE TO FLAT HEAD
- c) LUBRICATION
- d) CLOSURE WELD FIXTURING IMPROVEMENT
- e) FILTER IN GAS PORT

D.P. - SHELL CRACKS & LEAKAGE

C.A.
- a) CLOSED DIE FORGING WITH ORIENTED GRAIN
- b) TIGHTER MATERIAL CONTROL, CHEMISTRY & HEAT TREATMENT

D.P. - LEAKAGE IN FUEL BELLOWS & END MEMBERS

- a) CLOSED DIE FORGING WITH ORIENTED GRAIN
- b) TIGHTER MATERIAL CONTROL, CHEMISTRY & HEAT TREATMENT.
- c) INCREASED THE LEAKAGE PATH WITH THICKER BELLOWS ATTACHMENT AREAS.

2 - THE FOLLOWING CHANGES HAVE BEEN MADE SINCE QUALIF.

- SOME RELAXATION OF METALLURGICAL REQUIREMENTS, I.E., 2% TO 3% DELTA FERRITE & 4 TO 3 GRAIN SIZE.

3 - THE FOLLOWING CONFIGURATIONS ARE BEING DELIVERED TO LMSC.

8247-471201-1 OXDR TANK & 8247-471202-1 FUEL TANK

4 - NOT APPLICABLE (SYSTEMS GROUP)

5 - PROBLEM AREAS, PAST AND PRESENT

- a) SCRATCHES & CONTAMINANTS CAUSING BELLOWS STICKING
- b) STRESS CORROSION & INTERGRANULAR CORROSION CRACKING
- C) DISTORTION & MISALIGNMENT OF SHELLS AT CLOSURE WELDING

MODEL 8247 START TANKS

FABRICATION CONTROL : AM 355

I PARENT BILLET.

A. BILLET STOCK IS PRODUCED BY THE COMSUMABLE ELECTRODE REMELT TECHNIQUE UNDER INERT GAS OR VACUUM.

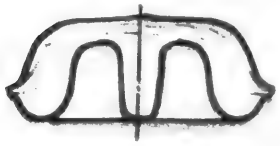
B. METALLOGRAPHIC SAMPLES ARE CUT FROM EDGE AND CENTER, AND THE MICROSTRUCTURE CHECKED TO ASSURE THAT IT IS FREE OF MASSIVE CARBIDES WHICH WILL NOT GO INTO SOLUTION WITH HEAT TREATMENT.

C. A ONE INCH THICK BLANK IS HEAT TREATED AS IN ITEM ID, PRIOR TO FORGING, AND CHECKED FOR CONFORMANCE TO THE MECHANICAL PROPERTIES REQUIRED.

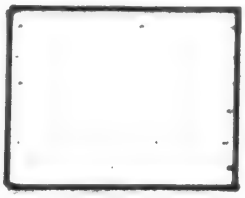
D. HEAT TREAT TO 1900°F FOR 3 TO 3½ HOURS. RAPID QUENCH & SUB ZERO COOL AT -100°F FOR 3 HOURS. HEATING TO 1750°F FOR ONE HOUR. RAPID QUENCH & SUB ZERO COOL TO -100°F FOR 3 HOURS. HEATING TO 1025°F FOR 3 TO 4 HOURS AND COOLING TO ROOM TEMPERATURE.

II CLOSED DIE FORGING

8247-471222-1F



8247-471225-1



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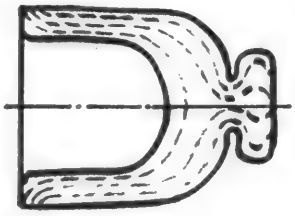

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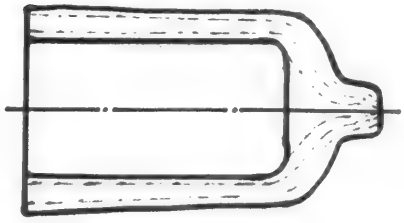


A. THE AM 355 PARTS ARE CLOSED DIE FORGING WITH CONTROLLED GRAIN FLOW, WITH THE EXCEPTION OF THE 8247-471225-1 STATIONARY HEAD, FUEL TANK. THESE ARE SUPPLIED IN THE EQUALIZED, OVER TEMPERED, AND DESCALED CONDITION (1425°F, 2 TO 4 HOURS, COOL, 1075°F 2 TO 4 HOURS AND COOL).

B. PRIOR TO ACCEPTANCE, A METALLOGRAPHIC SAMPLE IS CUT FROM EACH FORGING IN THE AS SUPPLIED CONDITION AND HEAT TREATED AS IN ITEM I D. THE SAMPLES THEN ARE EXAMINED TO DETERMINE THAT THE STRUCTURE IS FREE OF A GRAIN BOUNDARY CARBIDE NETWORK, FREE OF RETAINED AUSTENITE, FREE OF UNTEMPERED MARTENSITE AND THAT THE STRUCTURE DOES NOT CONTAIN MORE THAN 3% DELTA FERRITE AND THAT THE GRAIN SIZE IS AN ASTM 3 OR FINER.

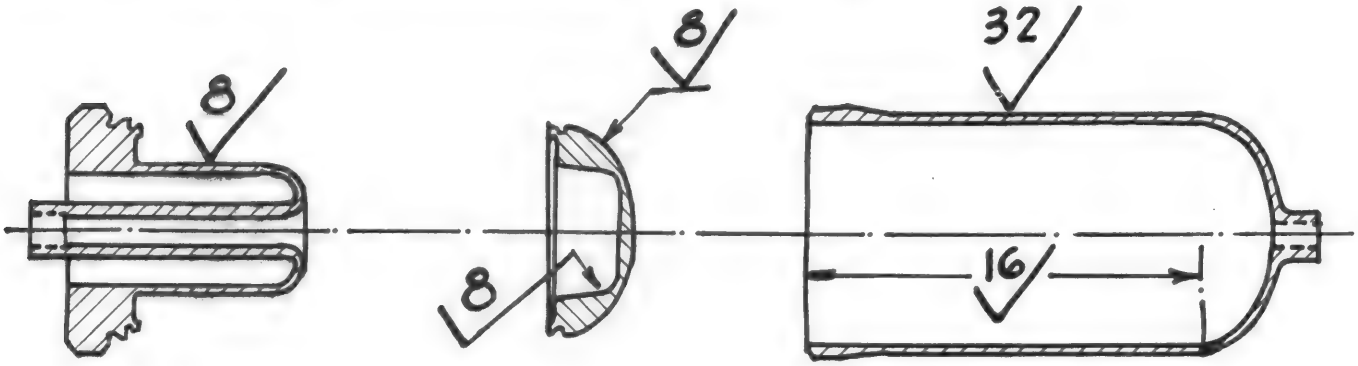
C. THREE HEAT TREATMENT TEST BARS ARE PROVIDED WITH EACH FORGING.

III MACHINED PARTS

A. ROUGH MACHINED PARTS:

THE PARTS ARE ROUGH MACHINED PRIOR TO THE HEAT TREATMENT IN ITEM I D. THREE TEST BARS ACCOMPANY EACH HEAT TREAT LOAD. AFTER HEAT TREATMENT A SAMPLE IS CUT FROM THE ROUGH MACHINED PART AND EXAMINED METALLURGICALLY AS IN ITEM 2B. THE TEST BARS ARE TESTED FOR CONFORMANCE TO THE MECHANICAL PROPERTIES REQUIRED.

B. FINISH MACHINED PARTS:



FINISHED MACHINED PARTS ARE CLEANED WITH SOLUTIONS THAT ARE CHLORIDE AND FLOURIDE FREE. A PASSIVATING SOLUTION OF INHIBITED NITRIC ACID IS USED FOR THE CHEMICAL CLEANING. THE PARTS ARE TESTED ON THE MASS SPECTROMETER TO A LESS THAN 1×10^{-9} STANDARD cc/SEC OF HELIUM.

MODEL 8247 ACCEPTANCE TEST PROCEDURE

I. VISUAL INSPECTION PERFORMED.

II. WEIGHT TEST.

III. PROOF TEST.

A. GAS SIDE FILL AND VOLUME CALIBRATION NO BELLOWS CYCLING. BELLOWS ARE THEN ALLOWED TO GO TO FREE LENGTH AND THE LIQUID SIDE IS FILLED.

B. THE TANK IS PROOF TESTED TO 2550 PSIG.

IV THE TANK IS DRAINED WITHOUT CYCLING THE BELLOWS AND THEN THE SHELL IS GAS TESTED TO 1700 PSIG.

V FLUSHING AND DRYING.
THE TANK IS FLUSHED INTERNALLY WITH DISTILLED WATER AND DRAINED. THE TANK IS THEN DRIED TO AMBIENT DEW POINT.

VI BELLOWS INTEGRITY.
THE BELLOWS IS LEAK TESTED AT 15 PSI ΔP EXTENDED. THE BELLOW IS THEN NESTED AND LEAK TESTED AT 15 PSI ΔP AND 150 PSI ΔP.

VII. LUBRICATION APPLICATION.
THE BELLOWS IS RETAINED IN A NESTED POSITION WITH VACUUM AND THE TANK IS LUBRICATED. THE LUBRICANT DISTRIBUTION IS THEN PERFORMED BY CYCLING THE BELLOWS 22 TIMES IN VARIOUS POSITIONS.

VIII VOLUME CALIBRATION (LIQUID SIDE).
THE LIQUID SIDE OF THE TANK IS CALIBRATED BY CYCLING 15 TIMES, TO DISPLACE THE AIR IN THE TANK, WITH DISTILLED WATER

IX FLUSHING AND DRYING.
THE TANK IS FLUSHED ON THE LIQUID SIDE ONLY, WITH FILTERED DISTILLED WATER, THEN DRIED TO A DEW POINT OF -20° F.

X. HANDLING AFTER ACCEPTANCE.
THE AIR VALVES AND PLUGS ARE INSTALLED AND THE GAS SIDE OF THE TANK PRESSURIZED TO 35 PSIG TO RETAIN THE BELLOWS IN A NESTED POSITION.
THE TANK IS CHECKED WITH THE DYE PENETRANT METHOD.
THE TANK IS COATED WITH SPRAYLAT FOR HANDLING PROTECTION DURING SUBSEQUENT TESTING.

MODEL 8247 BELLOWS CORE

I MATERIAL.
THE MATERIAL USED IN THE CORE IS AM 350. THE THICKNESSES USED ARE 0.007" AND 0.014".

II MELTING PRACTICE.
CONSUMABLE ELECTRODE REMELT TECHNIQUE IS PREFERRED. HOWEVER AIRMELTED MATERIAL HAS BEEN ALLOWED THAT COMPLIES WITH ALL THE REQUIREMENTS. (CHEMISTRY, INCLUSIONS, MECHANICAL PROPERTIES).

III HEAT TREATMENT.
THE MATERIAL IS ANNEALLED BY THE REROLLER PRIOR TO FINAL SIZING, BY HEATING TO 1900°F TO 1975°F FOR 15 MINUTES AND THEN QUENCHING.

IV HARDNESS ROCKWELL "C 25" OR LOWER.
THE FORMING, PUNCHING AND WELDING ARE DONE IN THIS CONDITION.

V END DIAPRAGMS.
THE HEAVIER 0.014" END DIAPHRAGMS ARE BLANKED, FORMED, HEAT TREATED AND THEN THE I.D. AND O.D. ARE SIZED.

VI WELDING.
THE CORE IS THEN WELDED COMPLETE WITH HEAVIER END DIAPHRAGMS.

VII HEAT TREATMENT.

THE CORE IS THEN HEAT TREATED IN A RETORT UNDER INERT GAS TO THE SCT 850 CONDITION.
HEAT TO 1710° F FOR 15 MINUTES, RAPID QUENCH TO ROOM F°.
COOL TO - 100 °F FOR 3 HOURS
WARM TO ROOM °F
HEAT TO 850°F FOR 3 HOURS
COOL TO ROOM °F.

VIII PROBLEMS :

A HIGH REJECTION RATE IS ENCOUNTERED BY THE VENDOR BECAUSE OF WARPING OF THE CORE DURING HEAT TREAT.

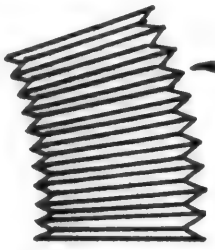
A PARALLEL DEVELOPMENT EFFORT BY THE VENDOR, WITH BELL ASSISTANCE, IS HOPED TO REDUCE THIS REJECTION RATE.

BAC RECOMMENDS HEAT TREATMENT OF BLANKS TO SCT 1025 CONDITION WHICH WILL RESULT IN A ROCKWELL C 35-38. THE FORMING, SIZING & WELDING WILL BE DONE IN THIS CONDITION. THE CORE WILL THEN BE HEAT TREATED TO AN SCT 850 CONDITION AS REQUIRED IN THE BOOK FORM DRAWING.

REJECTIONS:

ELLIPSE

FAILURE TO PASS PLUG GAUGE



EXCESSIVE CANT OR LEAN

FAILURE TO PASS RING GAUGE

MODEL 8247 START TANKS

DESIGN IMPROVEMENT

	001 - 002	201 - 202
HEAT TREATMENT	SCT 850 (AM355)	SCT 1000 (AM355)
GAS FILTER	NO	YES
INSIDE METAL FINISH	RMS 32	RMS 16
MOVEABLE HEAD -		
- FORGING	FORGED BISCUIT	CLOSED DIE FORG.
- CONTOUR	INSIDE CURVE	INSIDE FLAT
- FINISH	RMS 32	RMS 8
- MACHINING	NO GROOVES	VAC. BREAK IN & OUT
BELLOWS ASSY -		
- CONCENTRICITY	.020	.015
- OVALITY CHECK	NO	YES
- PLUG GAUGING	NO	YES
- SHIPPED	MECHANICAL NEST	VACUUM NEST
- END PLATES	.005 TK (OX) .007 TK (FUEL)	.009 TK (OX) .014 TK (FUEL)
STATIONARY HEAD	SAME AS MOVEABLE HEAD	

I DESCRIPTION OF COMP. TESTS

1. SHOCK

THREE SHOCKS IN EACH DIRECTION ALONG EACH OF THREE MUTUALLY PERPENDICULAR AXES. EACH SHOCK HAVING THE FOLLOWING CHARACTERISTICS: 40G MIN. PEAK ACCEL., 6 MILLISECONDS DURATION AND HAVING AN APPROXIMATE HALF-SINE WAVE FORM.

2. VIBRATION

45 MINUTES ALONG EACH OF THREE MUTUALLY PERPENDICULAR AXES AT A CONSTANT OCTAVE FREQUENCY SWEEP RATE FROM THE LOWER TO THE HIGHER FREQUENCY AT THE FOLLOWING LEVELS:

15 - 40 CPS AT 3.0 G
40 - 400 CPS AT 7.5 G
400-3000 CPS AT 20 G

3. ACCELERATION

ACCELERATE FOR 10 MINUTES IN EACH DIRECTION ALONG EACH OF THREE MUTUALLY PERPENDICULAR AXES AT A MIN. OF 12 G's

4. HI-TEMPERATURE

SOAK FOR 24 HRS. AT +160°F. REDUCE TEMPERATURE TO +140°F. WITH PROPELLANTS AT +140°F CONDUCT 50 CYCLES

5. LO-TEMPERATURE

SOAK FOR 24 HRS. AT -35°F. RAISE TEMPERATURE TO +10°F. WITH PROPELLANTS AT +10°F CONDUCT 50 CYCLES.

6. FLUID RESISTANCE

COMPLETELY FILL TEST UNIT WITH ACTUAL PROPELLANT AND APPLY OPERATING PRESSURE. HOLD IN THIS CONDITION AND MONITOR FOR 30/38 DAYS. DRAIN OFF PROPELLANT AND CALIBRATE WITH TEST PROPELLANT.

7. HUMIDITY

SOAK FOR 360 HRS. AT WET & DRY BULB TEMP. OF +120°F. WITHIN 1 HR. AFTER REMOVING UNIT FROM CHAMBER CONDUCT

1. INSULATION RESISTANCE
2. DIELECTRIC STRENGTH
3. COIL RESISTANCE
4. CALIBRATE

II COMPONENT DEV. TESTS

1. 8247-472-010 FUEL VALVE

1. SHOCK
2. VIBRATION
3. HI-TEMPERATURE
4. ENDURANCE (500 CYCLES)

2. 8247-472-050 OXIDIZER VALVE

1. SHOCK
2. VIBRATION
3. HI-TEMPERATURE
4. ENDURANCE (500 CYCLES)

3. 8247-472-020 FUEL G.G. SOLENOID VALVE

1. SHOCK
2. VIBRATION
3. ACCELERATION
4. HI-LO TEMPERATURE
5. FLUID RESISTANCE
6. ENDURANCE (2000 CYCLES)
7. HUMIDITY

4. 8247-472-025 OXID. G.G. SOLENOID VALVE

1. SHOCK
2. VIBRATION
3. ACCELERATION
4. HI-LO TEMPERATURE
5. FLUID RESISTANCE
6. ENDURANCE (2000 CYCLES)
7. HUMIDITY

5. 8247-472-035 OXID. DUAL CK. VALVE

1. SHOCK
2. VIBRATION
3. ACCELERATION
4. HI-LO TEMPERATURE
5. ENDURANCE (2000 CYCLES)
6. FLUID RESISTANCE

6. 8247-472-040 FUEL DUAL CK. VALVE

1. SHOCK
2. VIBRATION
3. ACCELERATION
4. HI-LO TEMPERATURE
5. ENDURANCE (2000 CYCLES)
6. FLUID RESISTANCE

7. 8247-472-055 OXID. VENTURI ASSEM.

1. SHOCK
2. VIBRATION
3. ACCELERATION
4. HI-LO TEMPERATURE
5. FLUID RESISTANCE

8. 8247-472-060 FUEL VENTURI ASSEM.

1. SHOCK
2. VIBRATION
3. ACCELERATION
4. HI-LO TEMPERATURE
5. FLUID RESISTANCE

9. 8247-472-065 OXID. FILL VALVE

1. SHOCK
2. VIBRATION
3. ACCELERATION
4. HI-LO TEMPERATURE
5. ENDURANCE (1000 CYCLES)
6. FLUID RESISTANCE

10. 8247-472-070 FUEL FILL VALVE

1. SHOCK
2. VIBRATION
3. ACCELERATION
4. HI-LO TEMPERATURE
5. ENDURANCE (1000 CYCLES)
6. FLUID RESISTANCE

11. 8247-472-075 OXID. MANUAL BLEED VALVE

1. DEVELOPED ON MODEL 8101 & RASCAL

12. 8247-472-080 FUEL MANUAL BLEED VALVE

1. DEVELOPED ON MODEL 8101 & RASCAL

13. 8247-472-015 PILOT OPERATED SOLENOID VALVE

1. DEVELOPED ON MODELS 8081 & 8096

14. 8247-472-045 FUEL & OXID. FILTER

1. TESTED WITH FUEL & OXID. VENTURIS

III DEV. TEST PROBLEMS

1. 8247-472-020-1 FUEL G.G. SOLENOID VALVE

FAILURE: LEAKAGE PAST POPPET UNDER STATIC PRESSURE AT ROOM TEMP.

REMARKS: TEFLON SEAT OF 1 PIECE CONFIGURATION. EFFECTIVE AREA CHG'D UNDER STATIC PRESSURE. REPLACED TEFLON WITH KEL-F. LEAKAGE EXPERIENCED AT HI-TEMPERATURE. REDESIGNED SEAT TO A CONFINED CONFIGURATION USING TEFLON. THIS CHG. CREATED THE 8247-472-020-3 VALVE

2. 8247-472-020-3 FUEL G.G. SOLENOID VALVE

FAILURE: LEAKAGE PAST POPPET DURING VIBRATION.

REMARKS: ADDED PADS TO MOUNTING LUGS TO DAMPEN HIGH FREQUENCIES. THIS CHG. CREATED THE 8247-472-020-5

3. 8247-472-020-5 FUEL G.G. SOLENOID VALVE

FAILURE: BRAZE FAILED ON MOUNTING LUG

REMARKS: REDUCED VIBRATION REQUIREMENTS TO THE FOLLOWING:

25 – 40 CPS AT 5G
40 - 400 CPS AT 7.5G
400 - 2000 CPS AT 15G

THIS CHG. CREATED THE 8247-472-020-7 VALVE. ALL 8247-472-020-7 VALVES ARE VIBRATED AT THIS LEVEL NOW.

4. 8247-472-025-1 OXID. G.G. SOLENOID VALVE

FAILURE: LEAKAGE PAST STATIC SEAL DURING LO-TEMPERATURE SOAK.

REMARKS: STATIC SEAL WAS "K" SEAL AND TEFLON COATED. TEFLON COATING FOUND PEELING. ATTEMPTED USING "OMNI" & "RACO" SEALS WITH NO SUCCESS. PROBLEM WAS SOLVED WITH "OMEGA" SEAL. THIS CHG. CREATED THE 8247-472-025-3 VALVE.

5. 8247-472-025-3 OXID. G.G. SOLENOID VALVE

FAILURE: HI ΔP DURING CALIB. AT HI TEMPERATURE.

REMARKS: SHANK OF POPPET EXTRUDED INTO OUTLET FITTING. REDESIGNED POPPET BY INCREASING SHANK DIAMETER AND CHANGING POINT CONTACT TO CHAMFER CONTACT. THIS CHG. CREATED THE 8247-472-025-5 VALVE CHG. ALSO INCLUDED ADDITION OF PADS ON MOUNTING LUGS.

IV DFCT ENGINE PROBLEMS

1. 8247-472-010-3 FUEL VALVE

FAILURE: EXCESSIVE LEAKAGE PAST SLIPPER SEALS.

REMARKS: VALVE WAS CALIBRATED AFTER ENGINE TESTS. DATA WITHIN SPECIFICATION. FAILED FINAL LEAKAGE TESTS. "O" RINGS HAD TAKEN A SET AND LOST THEIR DUROMETER. SIMILAR VALVE ON THE XRM-3 ENGINE DEMONSTRATED 45 SUCCESSFUL FIRINGS WITH NO PROBLEMS. INVESTIGATING NEW "O" RING MATERIAL ON MODEL 8096.

2. 8247-472-025-3 OXID. G.G. SOLENOID VALVE

FAILURE: VALVE REMOVED FROM ENGINE TO BE REWORKED INTO A-5 CONFIGURATION. CORROSION FOUND INSIDE OF VALVE.

REMARKS: ENCAPSULATION COPPER BRAZED. MACHINING OF ENCAPSULATION NOT CLOSELY CONTROLLED. RESULT- COPPER PENETRATION & PIN HOLES IN ENCAPSULATION ATTACKED BY ACID. CHANGED COPPER BRAZE TO GOLD-NICKEL BRAZE (LESS PENETRATION). ESTABLISHED TIGHTER CONTROL ON ENCAPSULATION MACHINING. THIS CHG. CREATED THE 8247-472-025-7 VALVE FOR FLIGHT VERIFICATION TESTS.

3. 8247-472-040-1 FUEL DUAL CK. VALVE

FAILURE: LEAKAGE PAST INLET POPPET

REMARKS: VALVE LEAKED AFTER HUMIDITY TEST. SEAT ON INLET POPPET FOUND OUT OF ITS GROOVE. CAUSE - HI-VELOCITY - SOURCE UNKNOWN. REDESIGNED SEAT TO A DOVETAIL CONFIGURATION. THIS CHANGE CREATED THE 8247-472-040-3 VALVE AND THE 8247-472-035-3 VALVE FOR FLIGHT VERIFICATION TESTS. IN ACCEPTANCE TESTS OF THE 8247-472-040-3 VALVE THE ΔP WAS OUT OF SPECIFICATION. IN THE REDESIGN THE POPPET HAD BEEN MADE LONGER. THE POPPET WAS SHORTENED AND THE OUTLET POPPET SPRING RETAINER WAS REDESIGNED TO PREVENT COCKING. THIS CHANGE NOW CREATED THE 8247-472-040-5 FOR FLIGHT VERIFICATION TESTS.

V FLIGHT VERIFICATION TESTS

1. 8247-472-035-3 OXID. DUAL CK. VALVE

   1. SHOCK
   2. VIBRATION
   3. HI-LO TEMPERATURE
   4. ENDURANCE (2000 CYCLES)

2. 8247-472-035-3 OXID. DUAL CK. VALVE

   1. SHOCK
   2. VIBRATION
   3. HI-LO TEMPERATURE
   4. 38 DAY STORAGE TEST ON START TANK SYSTEM.

3. 8247-472-040-5 FUEL DUAL CK. VALVE

   1. HI-LO TEMPERATURE
   2. SHOCK
   3. VIBRATION
   4 ENDURANCE (2000 CYCLES)

4. 8247-472-040-5 FUEL DUAL CK. VALVE

   1. HI-LO TEMPERATURE
   2. SHOCK
   3. VIBRATION
   4. 38 DAY STORAGE TEST ON START TANK SYSTEM.

5. 8247-472-025-7 OXID. G.G. SOLENOID VALVE

1. SHOCK
2. VIBRATION
3. HI-LO TEMPERATURE
4. 38 DAY STORAGE TEST ON START TANK SYSTEM.

6. 8247-472-025-7 OXID. G.G. SOLENOID VALVE

1. HI-LO TEMPERATURE
2. SHOCK
3. VIBRATION
4. ENDURANCE (2000 CYCLES)

7. 8247-472-020-7 FUEL G.G. SOLENOID VALVE

1. EXPLOSION PROOF
   A. SEA LEVEL - 5000 FT (10 CYCLES)
   B. AT 10,000 FT. (10 CYCLES)
2. ALTITUDE TEST
   A. 90,000 - 100,000 FT. AT .2 PSIA (100 CYCLES)

8. 8247-472-025-7 OXID. G.G. SOLENOID VALVE

1. EXPLOSION PROOF
   A. SEA LEVEL - 5000 FT (10 CYCLES)
   B. AT 10,000 FT. (10 CYCLES)
2. ALTITUDE TEST
   A. 90,000 - 100,000 FT. AT .2 PSIA (100 CYCLES)

VI FLIGHT VER. TEST PROBLEMS

1. 8247-472-025-7 OXID. G.G. SOLENOID VALVE

FAILURE: HI ΔP DURING CALIB AT HI-TEMP. FOLLOWING DYNAMIC TESTS.

REMARKS: SHOULDER ON POPPET FOUND DEFORMED. POPPET LIFT INCREASED FROM .006/.008 TO .014. STRESS LEVEL ON SHOULDER MARGINAL. SHOULDER WAS NOT INCREASED, WHEN SHANK WAS INCREASED DURING DEVELOPMENT TESTS, TO MAINTAIN SAME STRESS LEVEL. REDESIGNED POPPET TO INCREASE SHOULDER BEARING AREA. THIS CHANGE CREATED 8247-472-025-9 VALVE FOR RE-RUN OF FLIGHT VERIFICATION TESTS.

ELECTRICAL CHARACTERISTICS OF MODEL 8247 COMPONENTS

GAS GEN. FUEL SOLENOID VALVE 8247-472 020

INSULATION RESISTANCE	—	AT	ROOM AMBIENT & 500 VDC	= 500 MEGOHMS
	—	AT	EXTREME TEMP., HUMIDITY, ALTITUDE & 500 VDC	= 50 MEGOHMS
DIELECTRIC STRENGTH	—	AT	SEA LEVEL, 1000 VAC RMS 60 CPS	= 0.5 M AMPS
	—	AT	EXTREME TEMP., HUMIDITY, ALTITUDE & 1000 VAC RMS 60 CPS	= 2.0 M AMPS
COIL RESISTANCE	—	AT	70°F	= 8.5 ± 0.3 OHMS
CURRENT	—	AT	70°F SEA LEVEL & 30.5 VDC	= 3.72 AMPS MAX
PULL-IN VOLTAGE	—			= 18 VDC
DROP-OUT VOLTAGE	—			= 2.5 VDC

GAS GEN. OXIDIZER SOLENOID VALVE 8247-472 025

INSULATION RESISTANCE	—	AT	ROOM AMBIENT & 500 VDC	= 500 MEGOHMS
	—	AT	EXTREME TEMP., HUMIDITY, ALTITUDE & 500 VDC	= 50 MEGOHMS
DIELECTRIC STRENGTH	—	AT	SEA LEVEL, 1000 VAC RMS 60 CPS	= 0.5 M AMPS
	—	AT	EXTREME TEMP., HUMIDITY, ALTITUDE & 1000 VAC RMS 60 CPS	= 2.0 M AMPS
COIL RESISTANCE	—	AT	70°F	= 16.7 ± 0.5 OHMS
CURRENT	—	AT	70°F SEA LEVEL & 30.5 VDC	= 1.88 AMPS MAX
PULL-IN VOLTAGE	—			= 18 VDC
DROP-OUT VOLTAGE	—			= 2.5 VDC

PILOT OPERATED SOLENOID VALVE 8247-472 015

INSULATION RESISTANCE	—	AT	ROOM AMBIENT & 500 VDC	= 500 MEGOHMS
DIELECTRIC STRENGTH	—	AT	SEA LEVEL, 600 VAC RMS 60 CPS	= 0.5 M AMPS
COIL RESISTANCE	—	AT	80°F ± 20°F	= 12.5 ± 0.5 OHMS

MOTIONAL PICKUP TRANSDUCER (8247-472084-3)

CHARACTERISTICS

VOLTAGE AMPLITUDE - 1.4 TO 5V PEAK TO PEAK
(DEPENDING ON AIR GAP SETTING)

CONVERSION FACTOR - $\frac{\text{PEAK TO PEAK VOLTAGE}}{2.828}$ = RMS VOLTAGE

WAVE FORM - (BY HARMONIC ANALYSIS)
MODIFIED FULL SINE WAVE FORM

SECOND - HARMONIC	60% OF FUNDAMENTAL
THIRD - HARMONIC	2% OF FUNDAMENTAL
FOURTH - HARMONIC	10% OF FUNDAMENTAL
FIFTH - HARMONIC	0% OF FUNDAMENTAL

FREQUENCY - 958 CPS CORRESPONDING TO ENGINE SPEED OF 24,800 RPM

MAX. ACCELERATION - 1940 CPS^2 CORRESPONDING TO THEORETICAL dn/dt OF 50,000 RPM/SEC WITH DRY PUMP AND BOTH START TANKS FULLY LOADED AND PRESSURIZED

DC RESISTANCE - 57.5 ± 2.5 OHMS

AC IMPEDANCE - 100 OHMS NOMINAL AT 1000 CPS

ELECTRONIC GATE (8247-472283-3)

PURPOSE:

A. PROVIDE OVERSPEED SHUT-DOWN CAPABILITY
B. JUNCTION POINT FOR POWER TO ENGINE SOLENOIDS

INPUT SIGNAL REQUIREMENTS

AMPLITUDE - 1.4 TO 5.0V PEAK TO PEAK (SPEC)
1V PEAK TO PEAK (MINIMUM ACTUAL)
WAVEFORM - NOT AFFECTED BY HARMONIC CONTENT OF SIGNAL
FREQUENCY - 0 TO 2800 CPS
INSTRUMENTATION TRANSFORMER OUTPUT - 60% OF INPUT AMPLITUDE

TRIP FREQUENCY - 1140 ± 20 CPS (ALL CONDITIONS)
TRIP FREQUENCY BANDWIDTH - 250 ± 50 CPS

ELECTRONIC GATE (8247-472283-3)

POWER INPUT -

VOLTAGE 19.5 TO 30.5 VDC, 500 MV RIPPLE
POWER (ELECTRONIC CIRCUITS) .1A AT 28 VDC
VOLTAGE DROP (GATE) 1 VDC @ 19.5 V AND RATED LOAD
1.25 VDC @ 30.5 V AND RATED LOAD
VOLTAGE DROP (TOTAL - INCLUDING 4 FEET OF WIRE)
1.4 VDC @ 19.5 V AND RATED LOAD
1.85 VDC @ 30.5 V AND RATED LOAD

LINE VOLTAGE TRANSIENT - NO EFFECT

CIRCUIT PROTECTION - POLARITY REVERSAL DIODES

PART FAILURE - DESIGN OBJECTIVE - THAT A SINGLE PART FAILURE DOES NOT LATCH THE RELAYS

RESET CIRCUIT - 19.5 TO 30.5 VDC 500 MV RIPPLE TO RELAY RESET COILS

ELECTRONIC GATE (8247-472283-3)

ACCEPTANCE TEST (100%)

RELAY ONLY

VIBRATION - 5 TO 45 CPS AT .3 IN D A
45 TO 3000 CPS AT 30 G

CYCLES - 2000 CYCLES AT 25°C
2000 CYCLES AT -65°C
2000 CYCLES AT +125°C

COMPONENT

INSULATION RESISTANCE (500 MEGOHM AT 500 VDC)
CONTINUITY (SIMPSON MODEL 260)
LINE TRANSIENT (200 TO 300 VOLT NEG SPIKE)
TRIP FREQUENCY (ROOM TEMPERATURE, 0°F + 160°F)
TRIP FREQUENCY BAND WIDTH (ROOM TEMPERATURE, 0°, +160°F)
SHOCK - 40G (MINIMUM)
VIBRATION - 25 TO 2000 CPS AT 5G

ELECTRONIC GATE 8247-472283 TESTS

R & D

1. REFERENCE TEST
   (a) LINE TRANSIENT
   (b) BANDWIDTH AND SENSITIVITY
   (c) INSULATION RESISTANCE
   (d) RESISTANCE AND CONTINUITY
2. LOW (-65°F TO 0°F) & HIGH (+200°F TO +160°F) TEMP.
3. TEMP. SHOCK (+185°F TO -40°F TO +185°F TO ROOM AMBIENT)
4. EMI (MIL-I-26600 & 8247-947006)
5. HUMIDITY
6. SALT SPRAY
7. SHOCK
8. ACCELERATION
9. SINUSOIDAL VIBRATION (3000 CPS, 5 TO 20 G)
10. RANDOM VIBRATION

PFRT

1. ALTITUDE (0.2 PSIA MIN)
2. IGNITION PROOF

CABLE ASSY (8247-472291-1)

CONNECTORS - DEUTSCH CO. EXCEPT FOR PILOT OPERATED
SOL VALVE (TITEFLEX)
22005 (~DTK07) - SINGLE MOUNTING HOLE
22007 (~DTK06) - PLUG

WIRE - MIL-W-16878
TEFLON INSULATED, GA-20
TWISTED & SHIELDED

ROUTING - CONTROL WIRING ROUTED
SEPARATE FROM INSTRUMENTATION

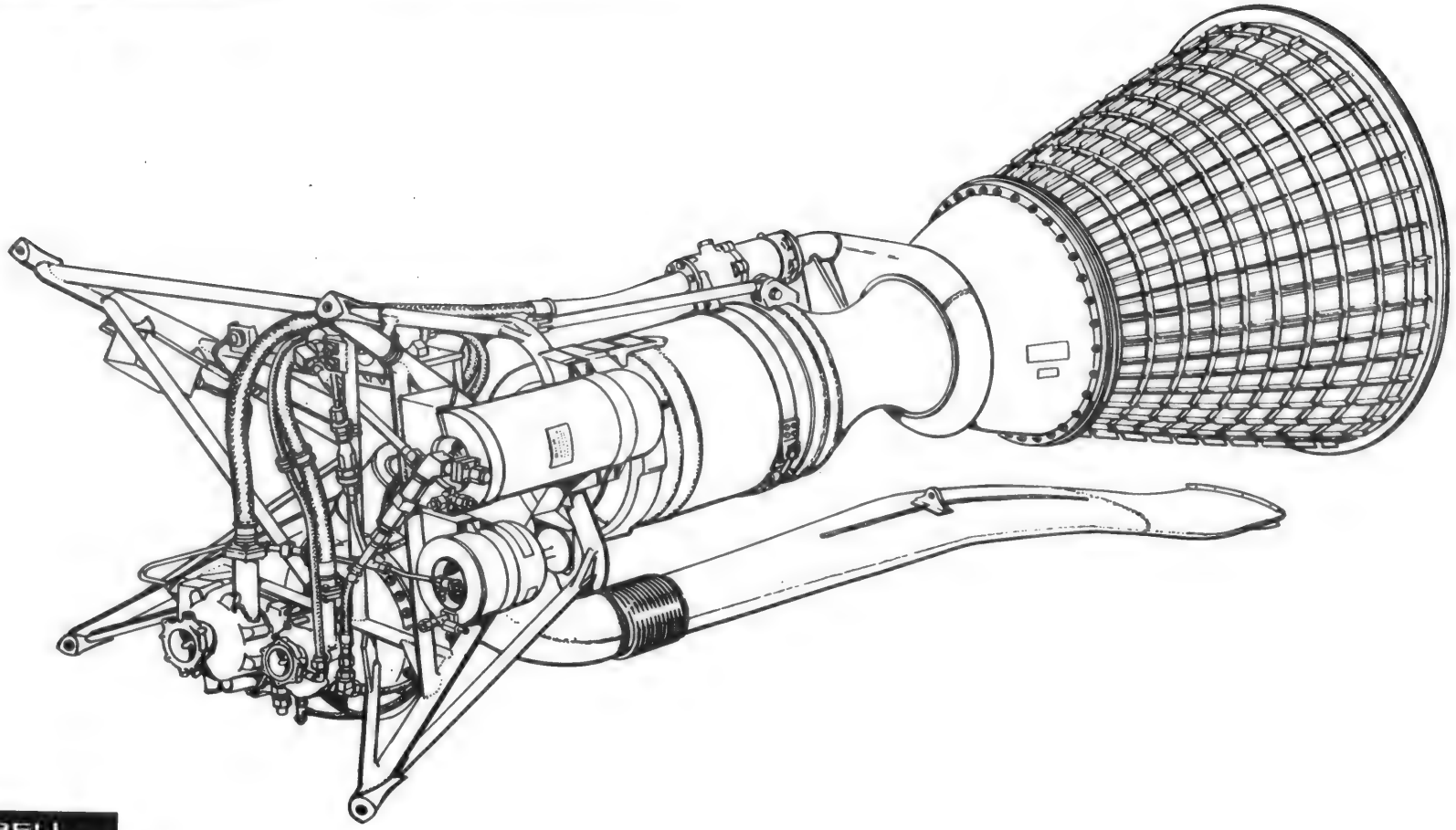
REPAIR - SPECIAL TOOLS REQ'D

ACCEPTANCE TEST - CONTINUITY
DIELECTRIC STRENGTH - 600 V RMS
INSULATION RESISTANCE - 500 VDC

CABLE CLAMPS - THOMAS ASSOC. TYPE TA73255 & TA713D SERIES - T & B TY5 SERIES

Model 8247

ENGINE ASSEMBLY



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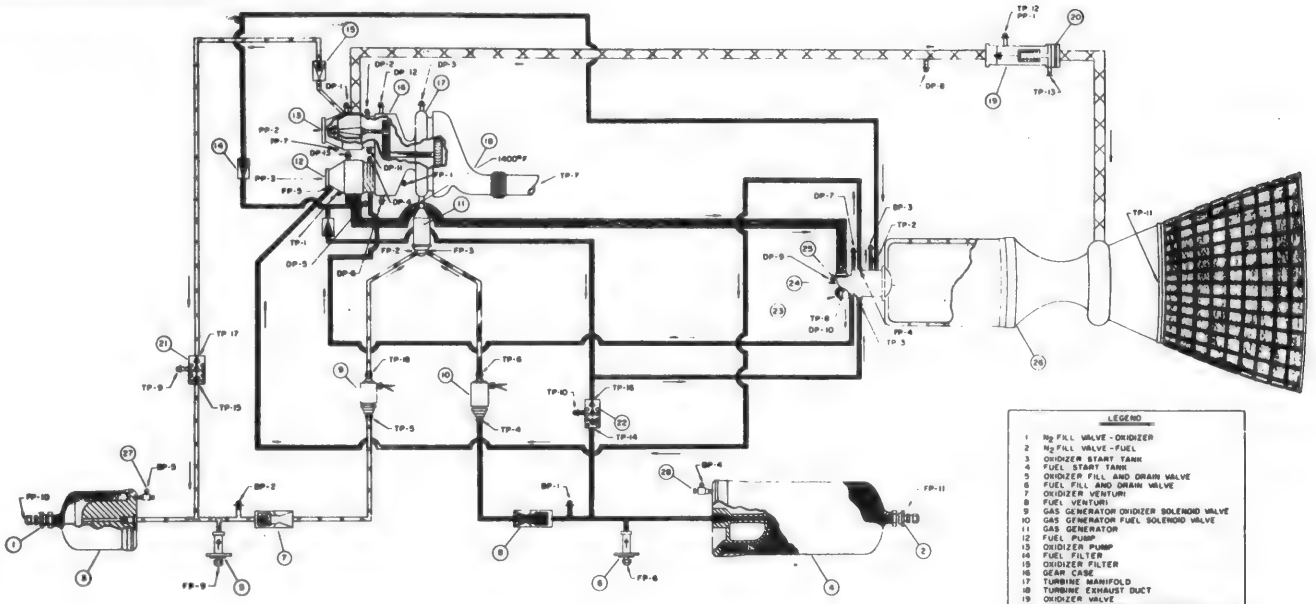
Model 8247 ROCKET ENGINE – PROPELLANT FLOW



LEGEND

1 N_2 FILL VALVE - OXIDIZER
2 N_2 FILL VALVE - FUEL
3 OXIDIZER START TANK
4 FUEL START TANK
5 OXIDIZER FILL AND DRAIN VALVE
6 FUEL FILL AND DRAIN VALVE
7 OXIDIZER VENTURI
8 FUEL VENTURI
9 GAS GENERATOR OXIDIZER SOLENOID VALVE
10 GAS GENERATOR FUEL SOLENOID VALVE
11 GAS GENERATOR
12 FUEL PUMP
13 OXIDIZER PUMP
14 FUEL FILTER
15 OXIDIZER FILTER
16 GEAR CASE
17 TURBINE MANIFOLD
18 TURBINE EXHAUST DUCT
19 OXIDIZER VALVE
20 OXIDIZER FRANGIBLE DISC (RUPTURE - 180 PSI)
21 CHECK VALVE AND BLEED PORT (OXIDIZER)
22 CHECK VALVE AND BLEED PORT (FUEL)
23 PILOT-OPERATED SOLENOID VALVE
24 FUEL VALVE
25 FUEL FRANGIBLE DISC (RUPTURE - 525 PSI)
26 THRUST CHAMBER
27 OXIDIZER BLEED VALVE
28 FUEL BLEED VALVE

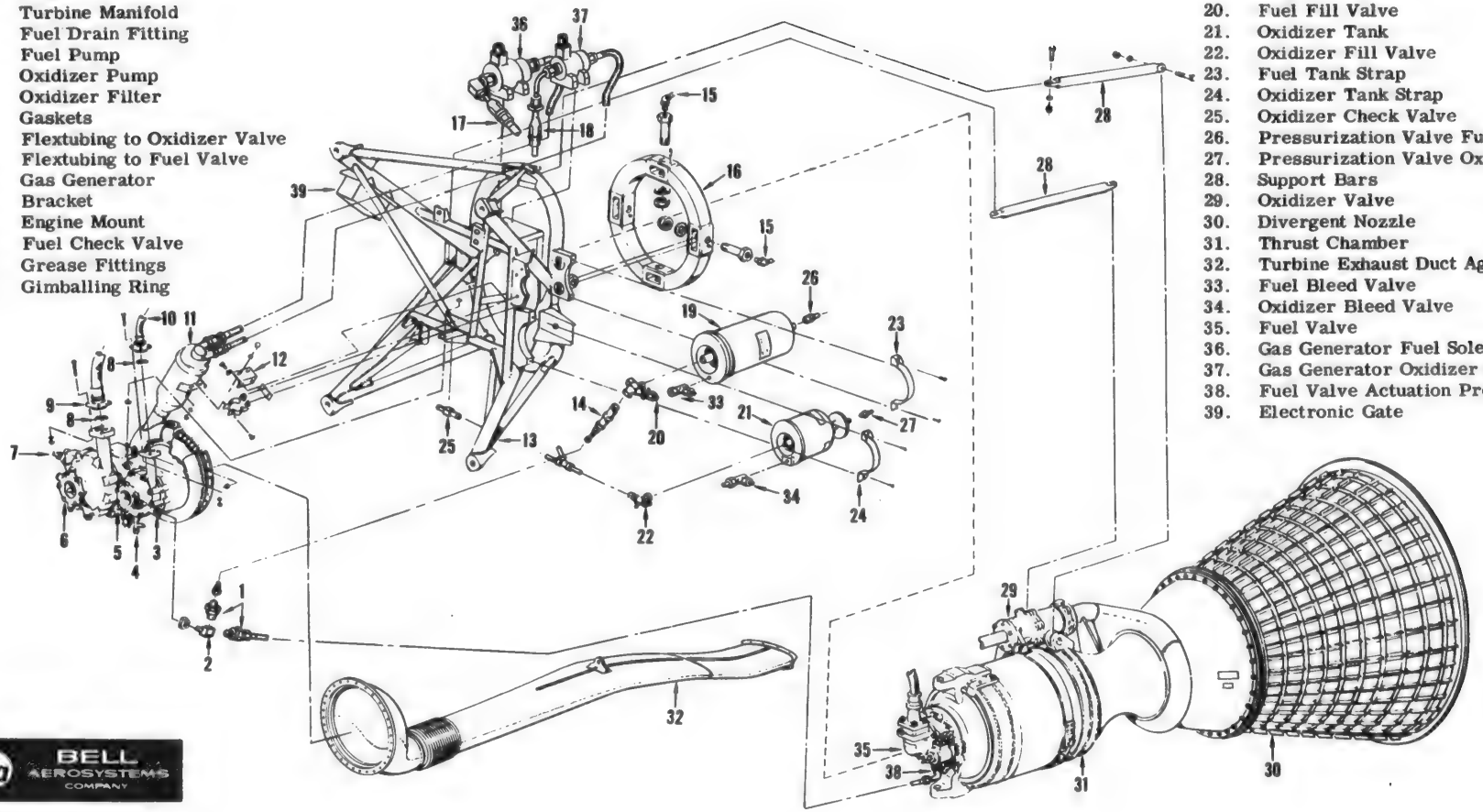
OXIDIZER
FUEL RETURN
ORIFICE AND FILTER
DRAIN, BLEED OR TEST POINT
FUEL

BELL AEROSYSTEMS COMPANY

Model 8247

ENGINE COMPONENTS

1. Fuel Filter
2. Elbow
3. Turbine Manifold
4. Fuel Drain Fitting
5. Fuel Pump
6. Oxidizer Pump
7. Oxidizer Filter
8. Gaskets
9. Flextubing to Oxidizer Valve
10. Flextubing to Fuel Valve
11. Gas Generator
12. Bracket
13. Engine Mount
14. Fuel Check Valve
15. Grease Fittings
16. Gimballing Ring
17. Fuel Filtered Venturi
18. Oxidizer Filtered Venturi
19. Fuel Tank
20. Fuel Fill Valve
21. Oxidizer Tank
22. Oxidizer Fill Valve
23. Fuel Tank Strap
24. Oxidizer Tank Strap
25. Oxidizer Check Valve
26. Pressurization Valve Fuel
27. Pressurization Valve Oxidize
28. Support Bars
29. Oxidizer Valve
30. Divergent Nozzle
31. Thrust Chamber
32. Turbine Exhaust Duct Agena '
33. Fuel Bleed Valve
34. Oxidizer Bleed Valve
35. Fuel Valve
36. Gas Generator Fuel Solenoid '
37. Gas Generator Oxidizer Solen
38. Fuel Valve Actuation Pressur
39. Electronic Gate

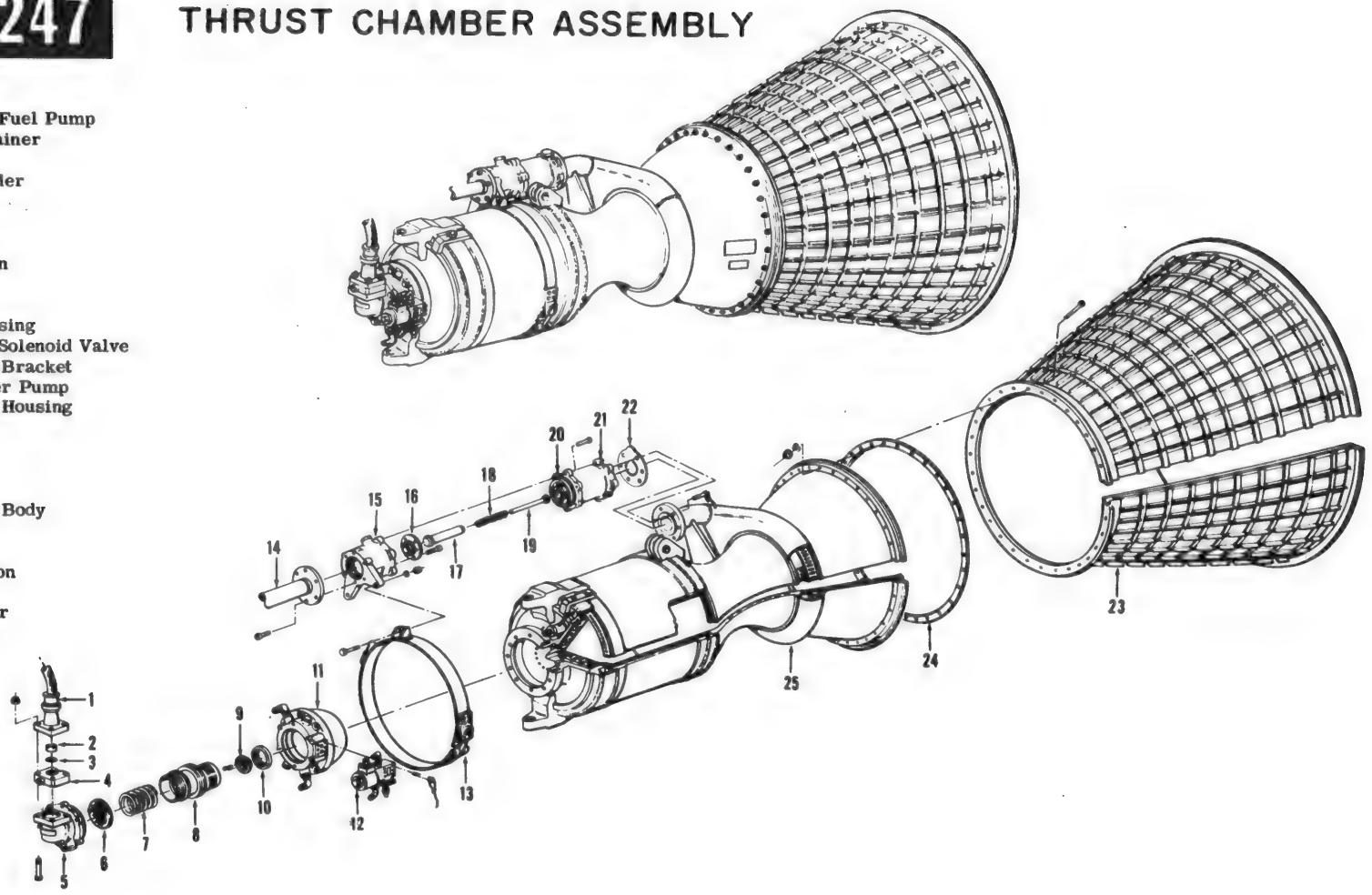


BELL AEROSYSTEMS COMPANY

Model 8247

THRUST CHAMBER ASSEMBLY

1. Flex Tubing to Fuel Pump
2. Burst Disc Retainer
3. Burst Disc
4. Burst Disc Holder
5. Elbow
6. Screen
7. Spring
8. Actuating Piston
9. Retainer
10. Seat
11. Fuel Valve Housing
12. Pilot Operated Solenoid Valve
13. Oxidizer Valve Bracket
14. Tube to Oxidizer Pump
15. Oxidizer Valve Housing
16. Seat Assembly
17. Poppet
18. Spring
19. Spring Guide
20. Oxidizer Valve Body
21. Vent Fitting
22. Burst Disc
23. Nozzle Extension
24. Gasket
25. Thrust Chamber



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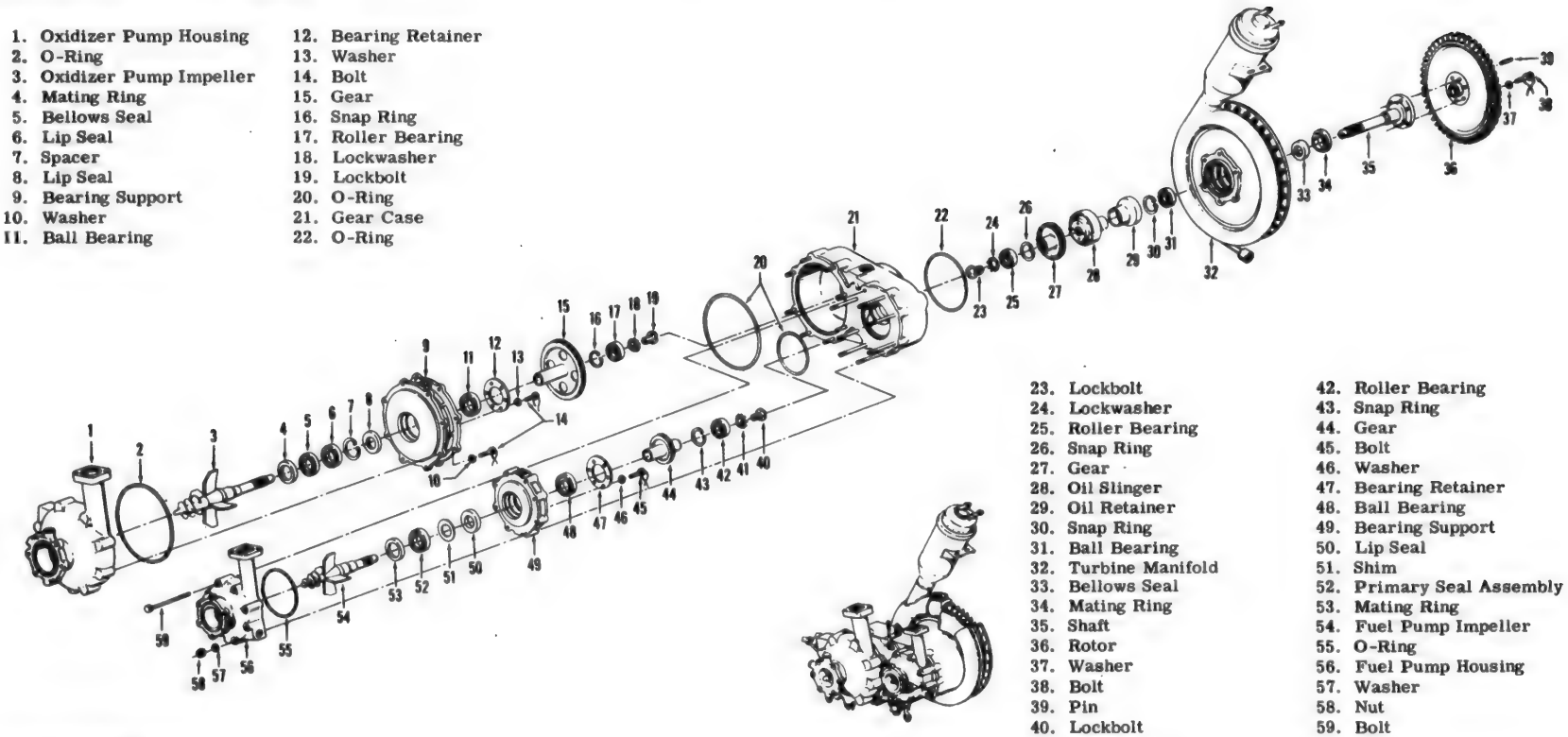
Model 8247 TURBINE PUMP ASSEMBLY

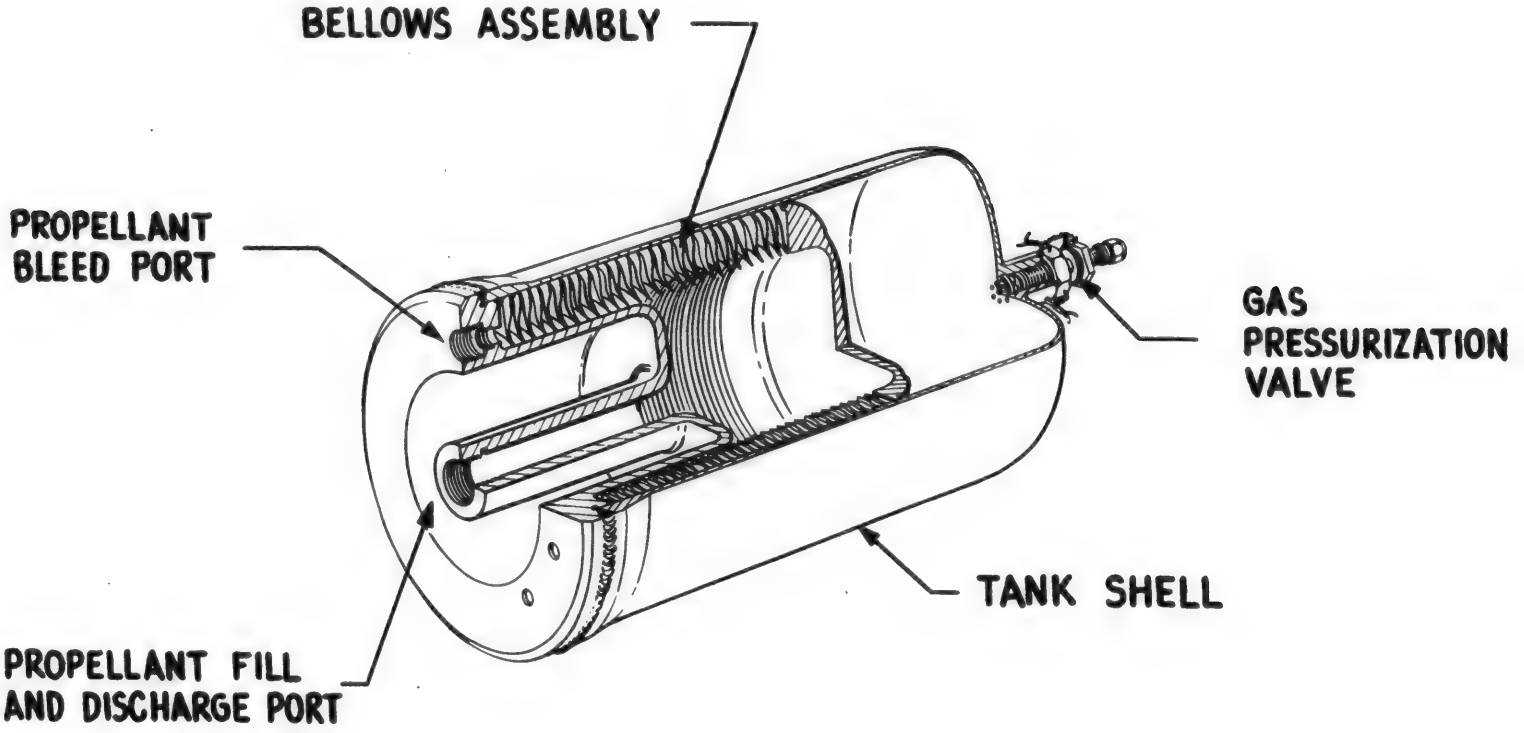
1. Oxidizer Pump Housing
2. O-Ring
3. Oxidizer Pump Impeller
4. Mating Ring
5. Bellows Seal
6. Lip Seal
7. Spacer
8. Lip Seal
9. Bearing Support
10. Washer
11. Ball Bearing
12. Bearing Retainer
13. Washer
14. Bolt
15. Gear
16. Snap Ring
17. Roller Bearing
18. Lockwasher
19. Lockbolt
20. O-Ring
21. Gear Case
22. O-Ring



23. Lockbolt
24. Lockwasher
25. Roller Bearing
26. Snap Ring
27. Gear
28. Oil Slinger
29. Oil Retainer
30. Snap Ring
31. Ball Bearing
32. Turbine Manifold
33. Bellows Seal
34. Mating Ring
35. Shaft
36. Rotor
37. Washer
38. Bolt
39. Pin
40. Lockbolt
41. Lockwasher
42. Roller Bearing
43. Snap Ring
44. Gear
45. Bolt
46. Washer
47. Bearing Retainer
48. Ball Bearing
49. Bearing Support
50. Lip Seal
51. Shim
52. Primary Seal Assembly
53. Mating Ring
54. Fuel Pump Impeller
55. O-Ring
56. Fuel Pump Housing
57. Washer
58. Nut
59. Bolt

BELL AEROSYSTEMS COMPANY

START TANK-FUEL

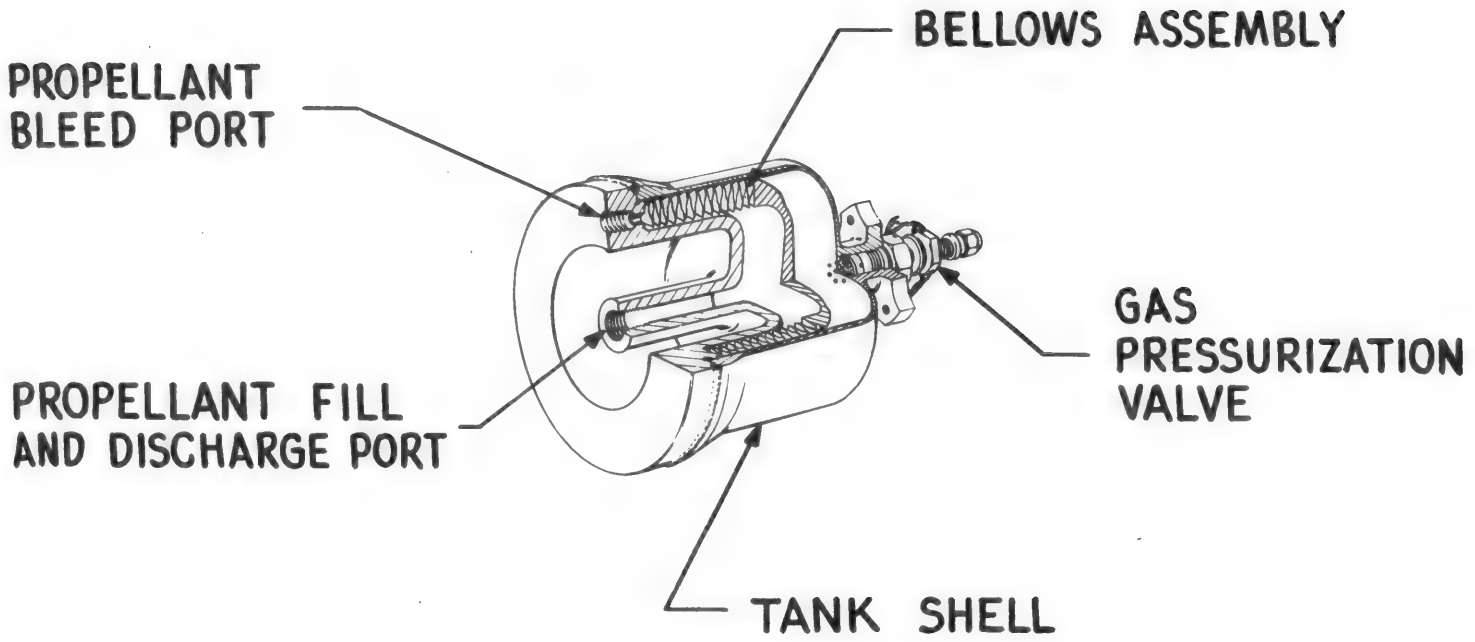


BELL AEROSYSTEMS COMPANY

8247-471202

94

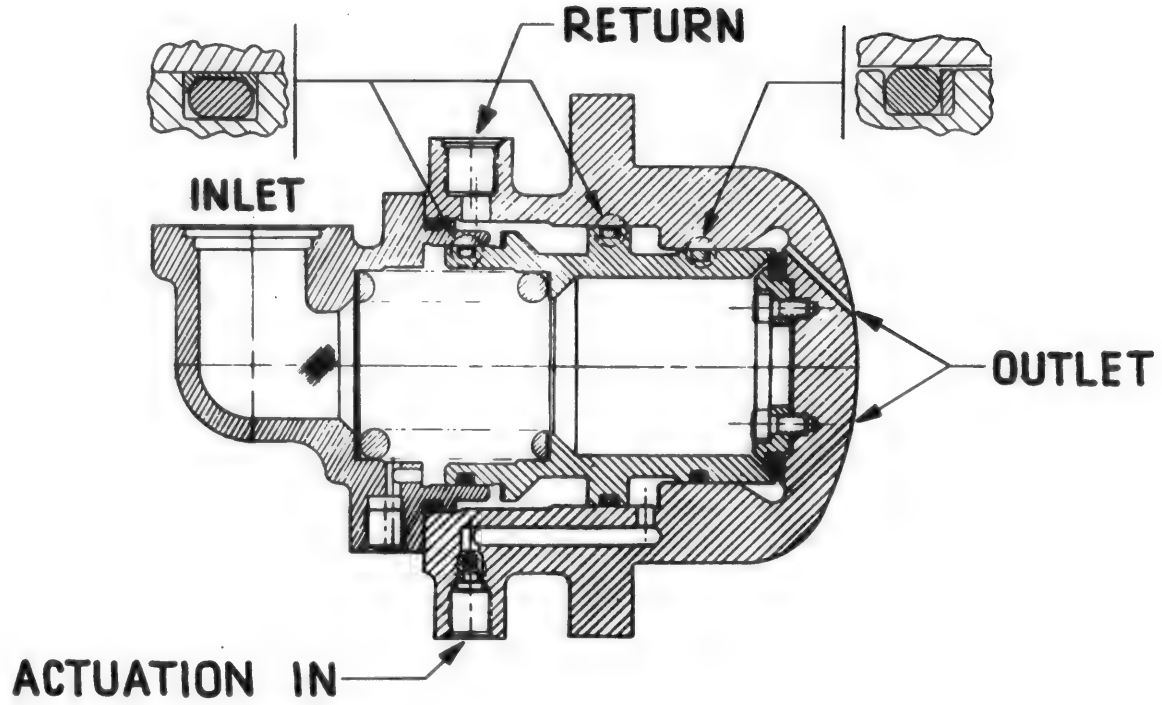
START TANK-OXIDIZER



BELL AEROSYSTEMS COMPANY

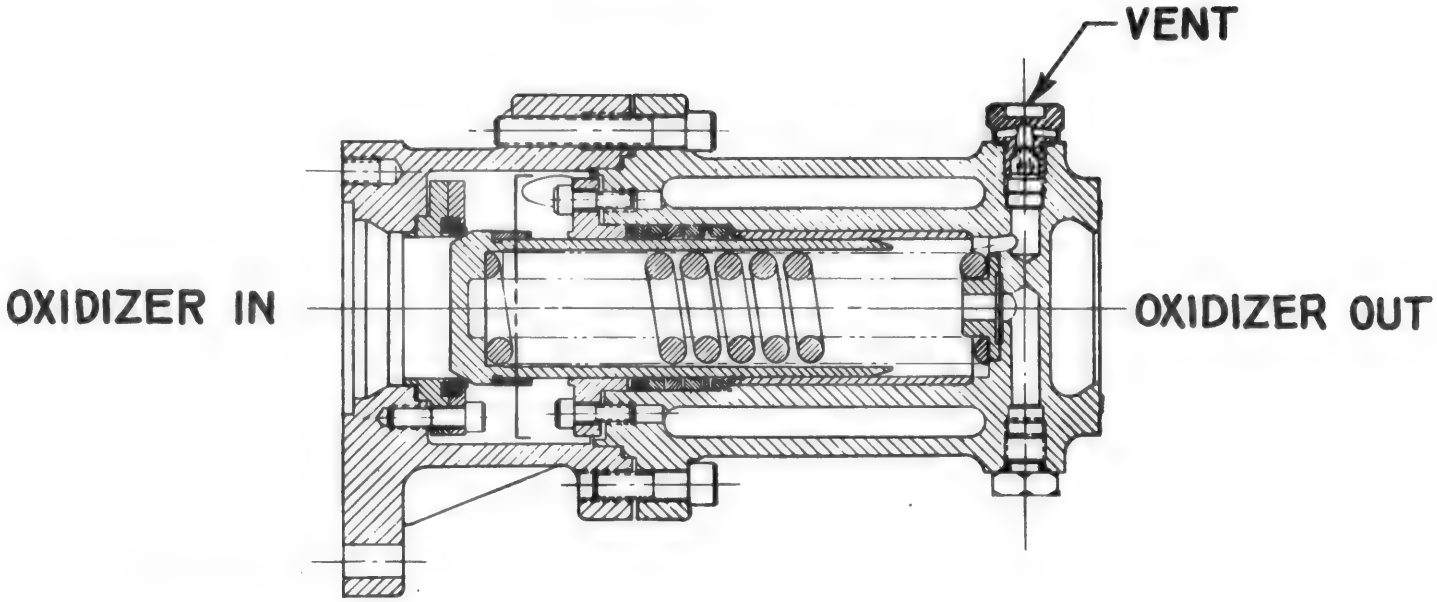
8247-471201-1

FUEL VALVE



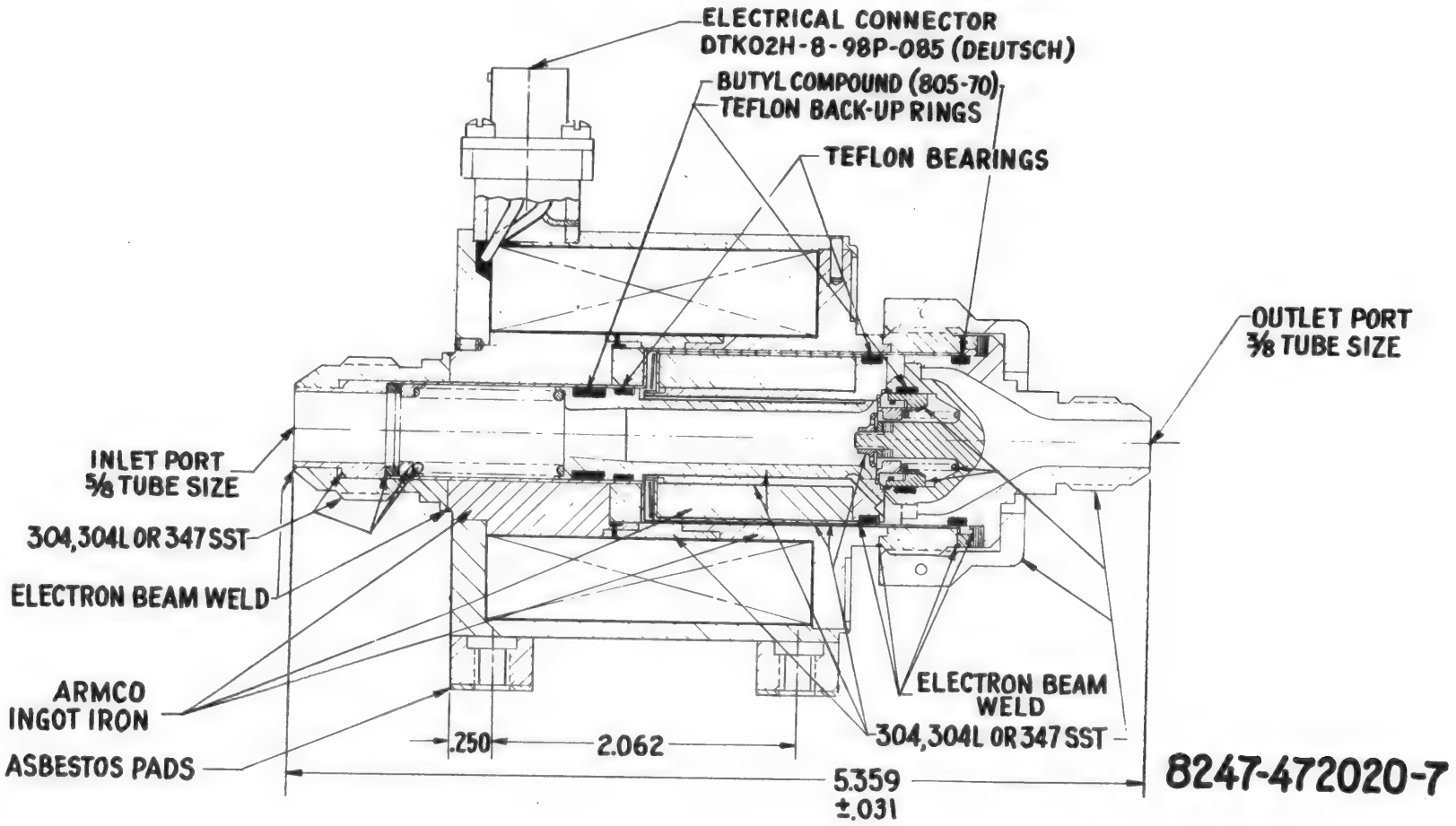
8247-472010-3

OXIDIZER VALVE

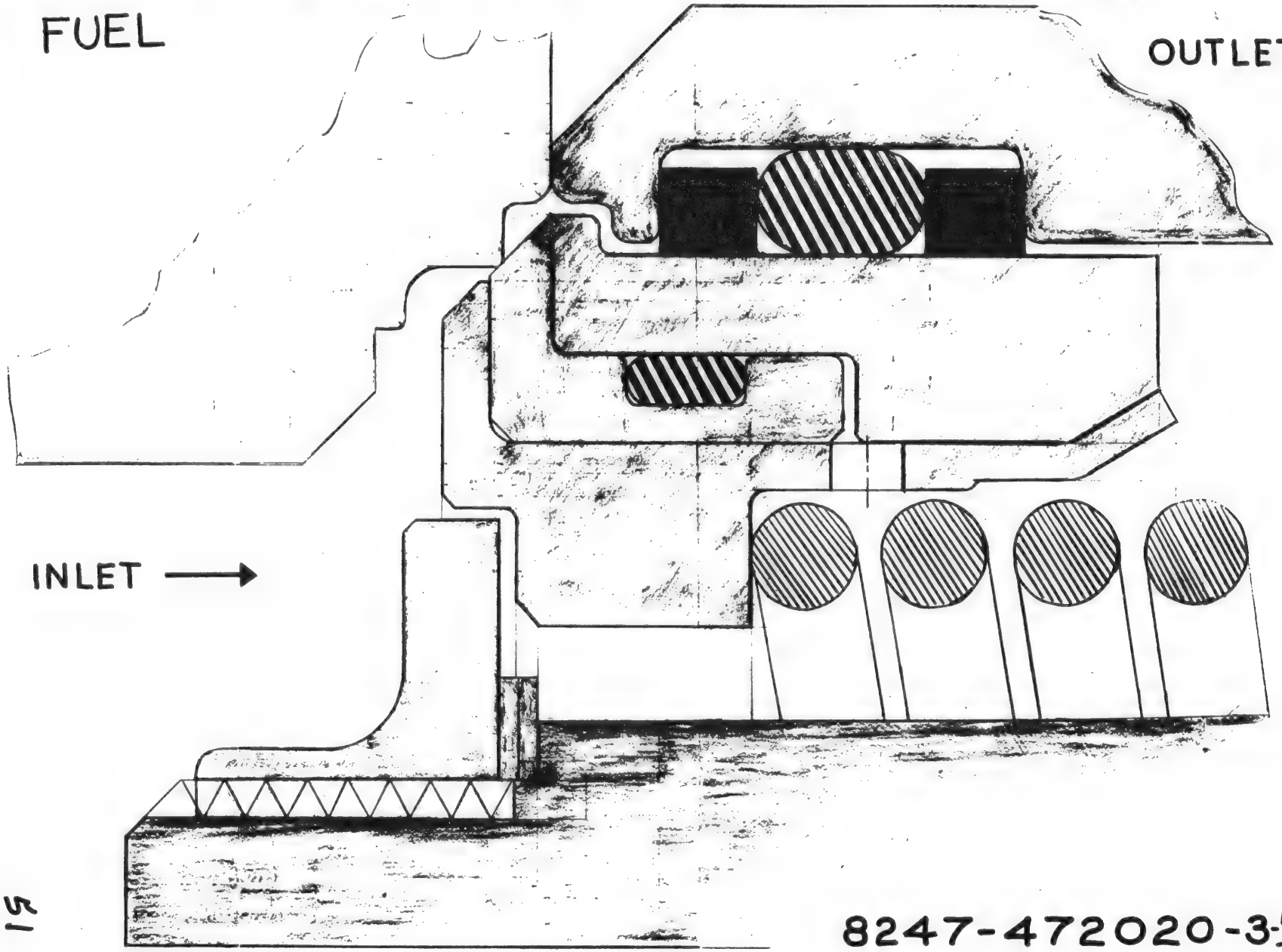


8427-472050-1

GAS GENERATOR FUEL SOLENOID VALVE

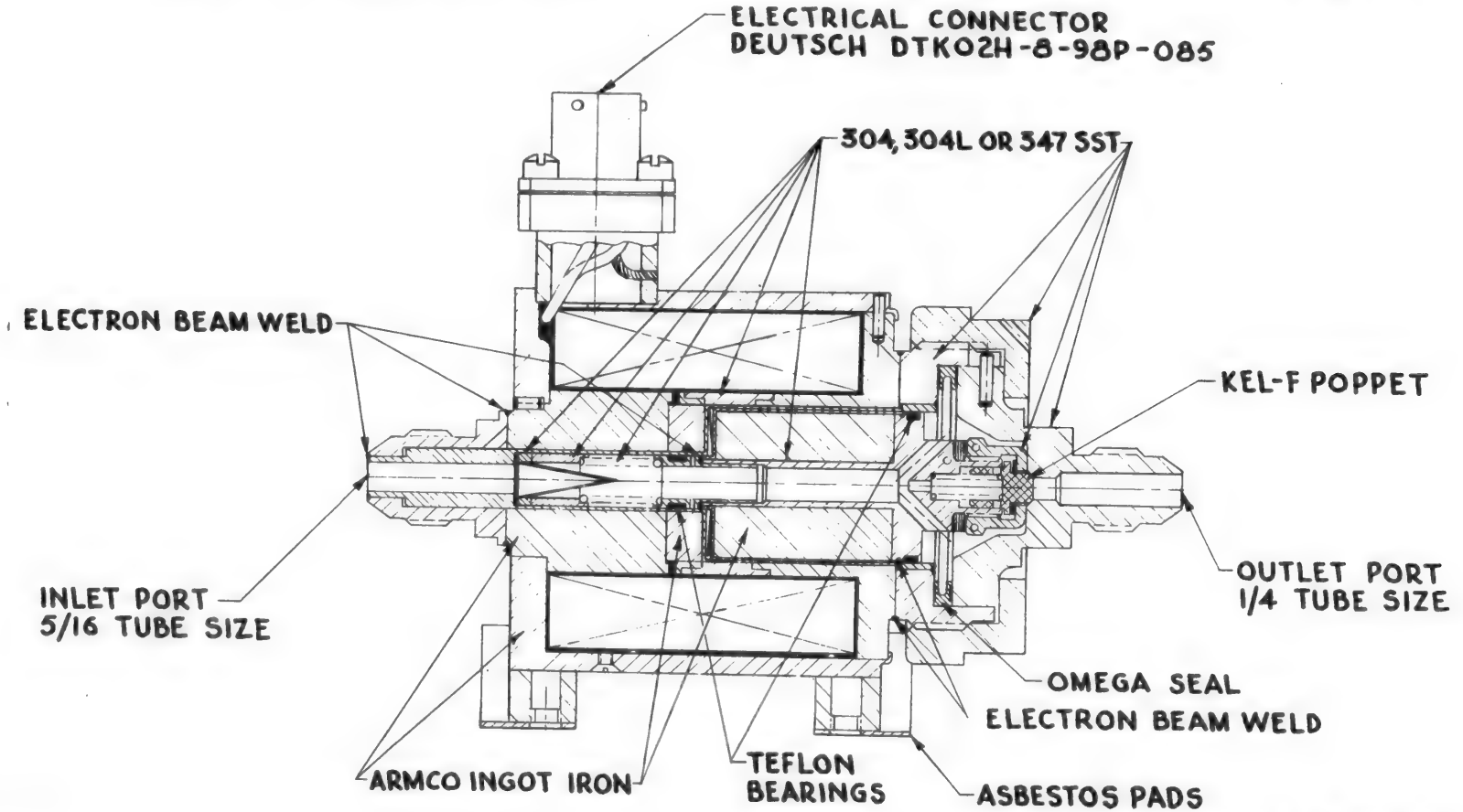


GAS GENERATOR SOLENOID VALVE



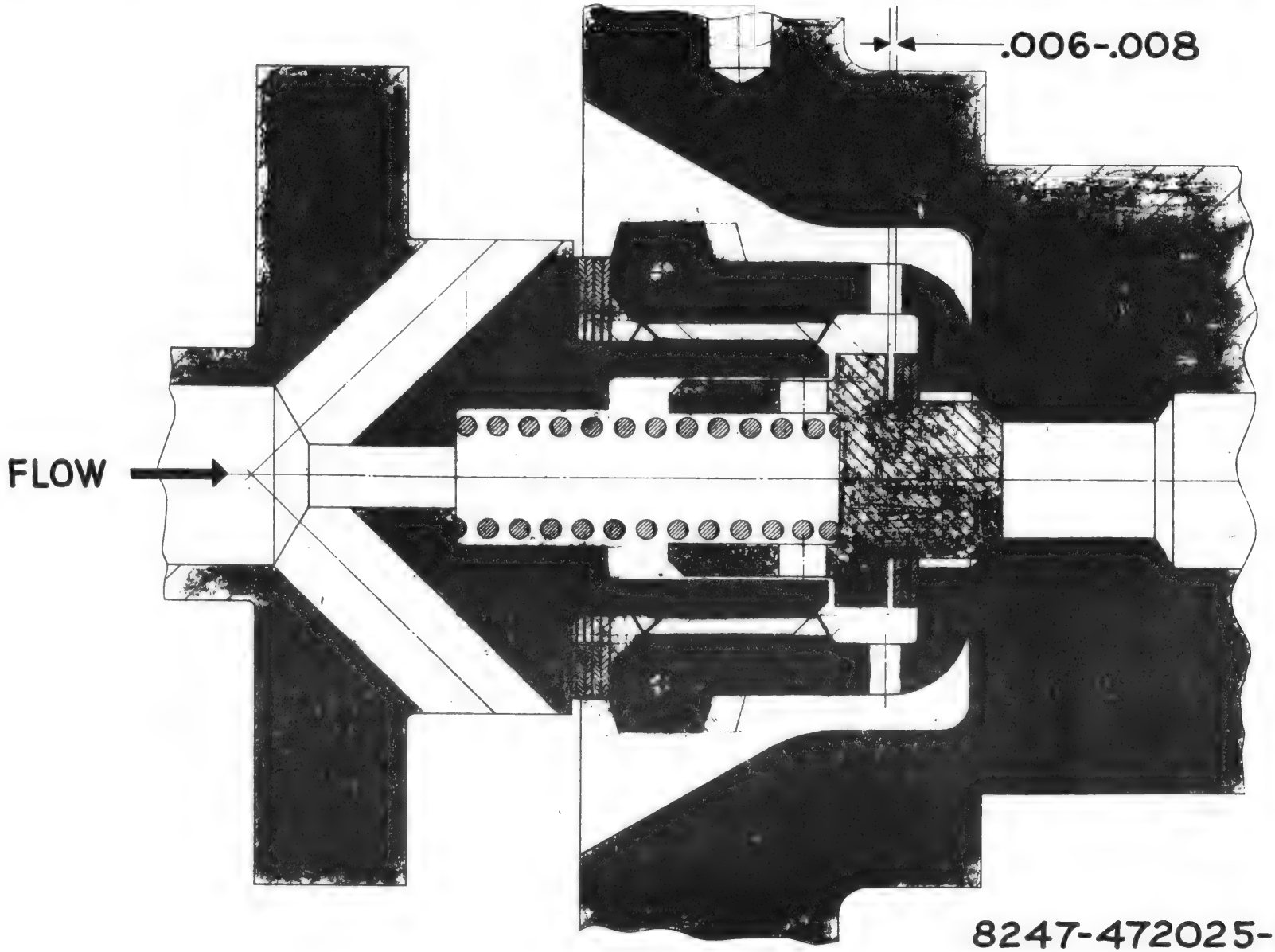
8247-472020-3-5-7

GAS GENERATOR OXIDIZER SOLENOID VALVE



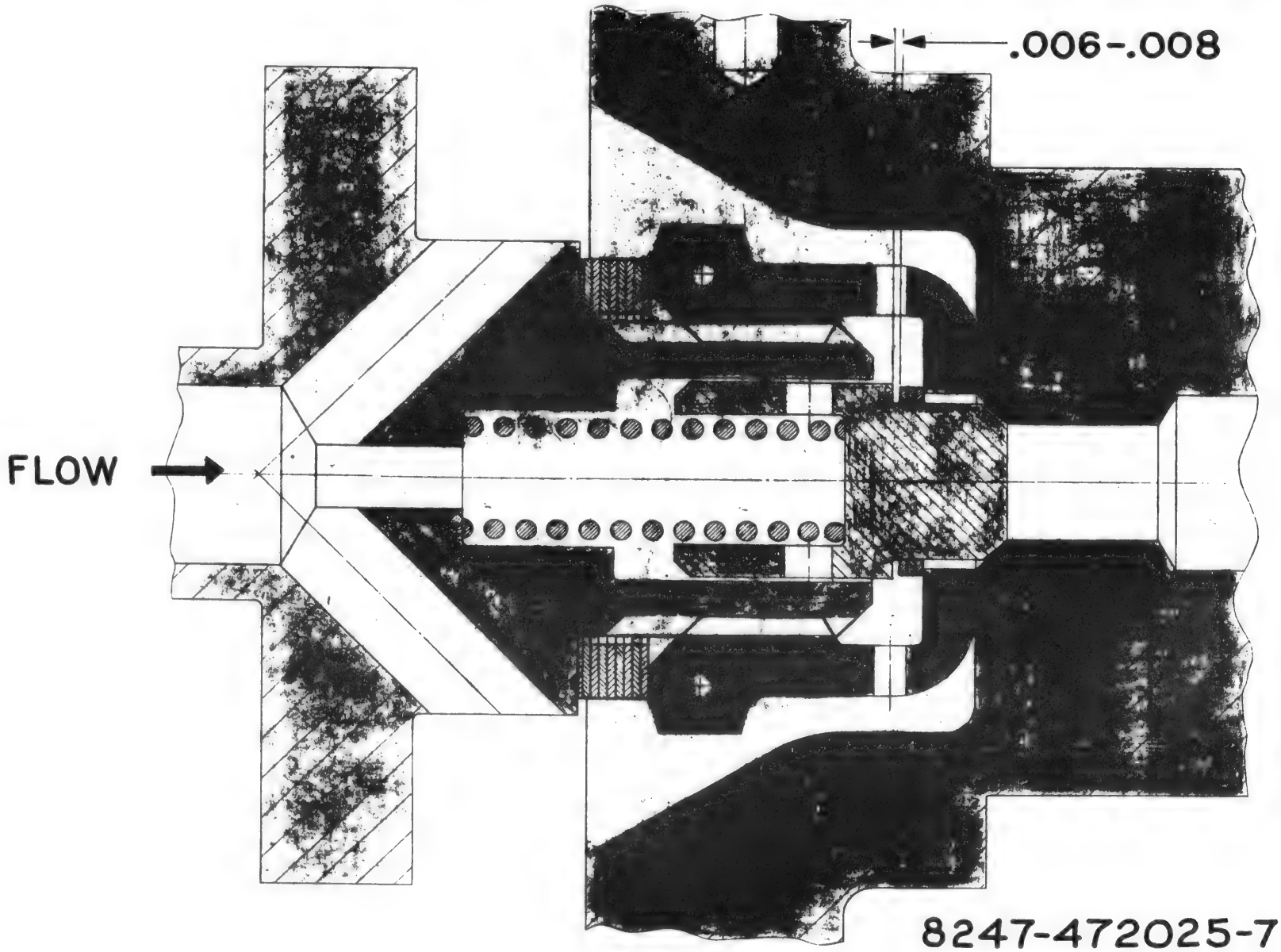
8247-472025-9

GAS GENERATOR OXIDIZER SOLENOID VALVE



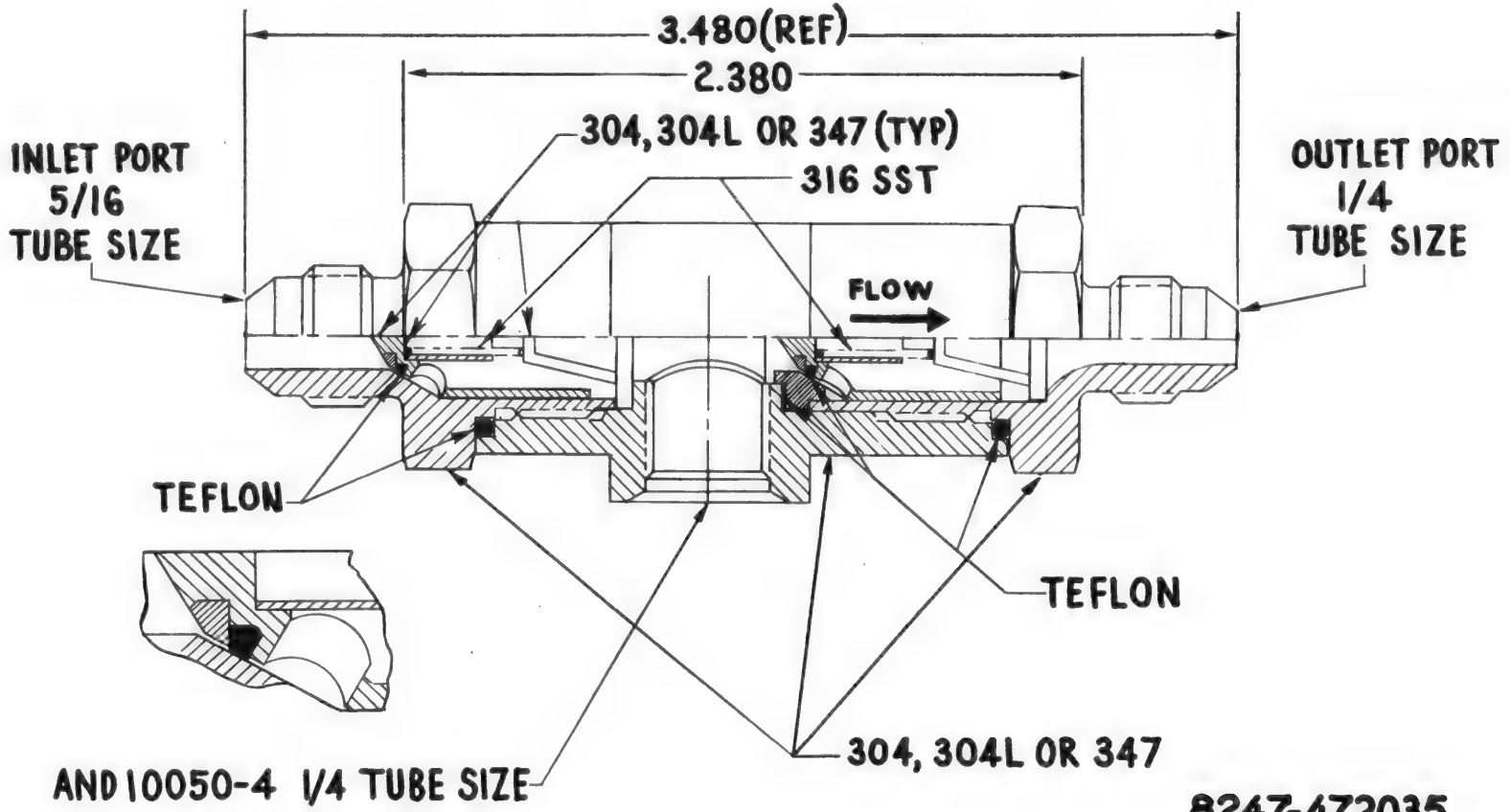
8247-472025-9

GAS GENERATOR OXIDIZER SOLENOID VALVE

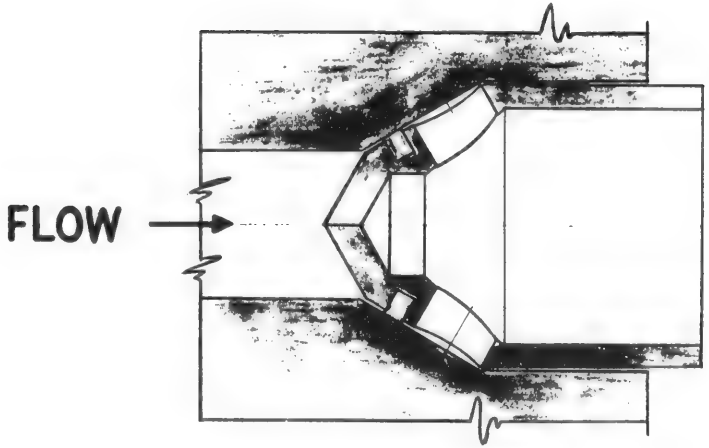


8247-472025-7

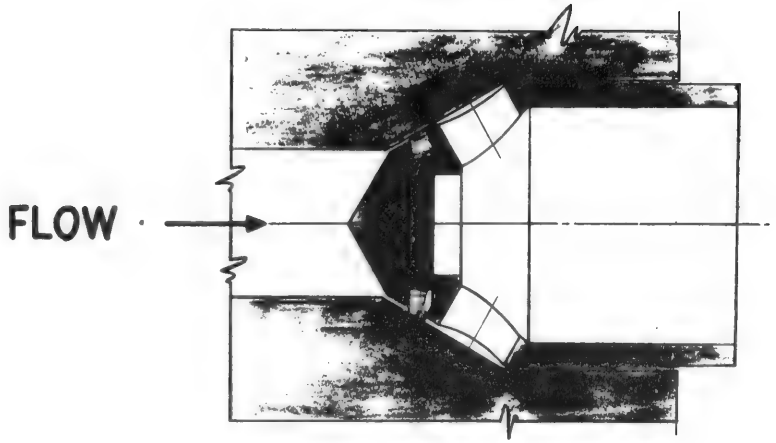
OXIDIZER DUAL-CHECK VALVE



OXIDIZER DUAL CHECK VALVE

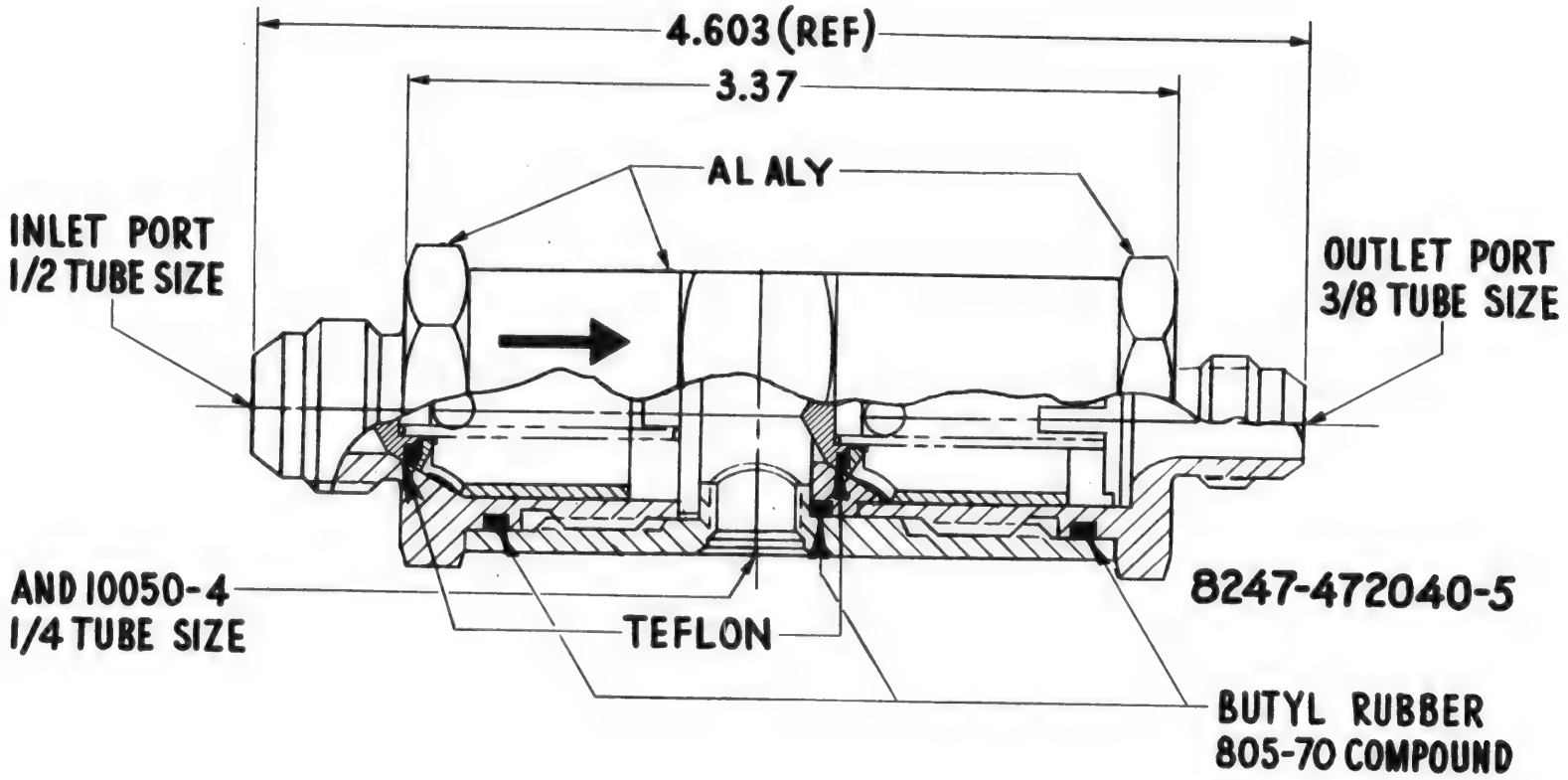


8247-472-035-1

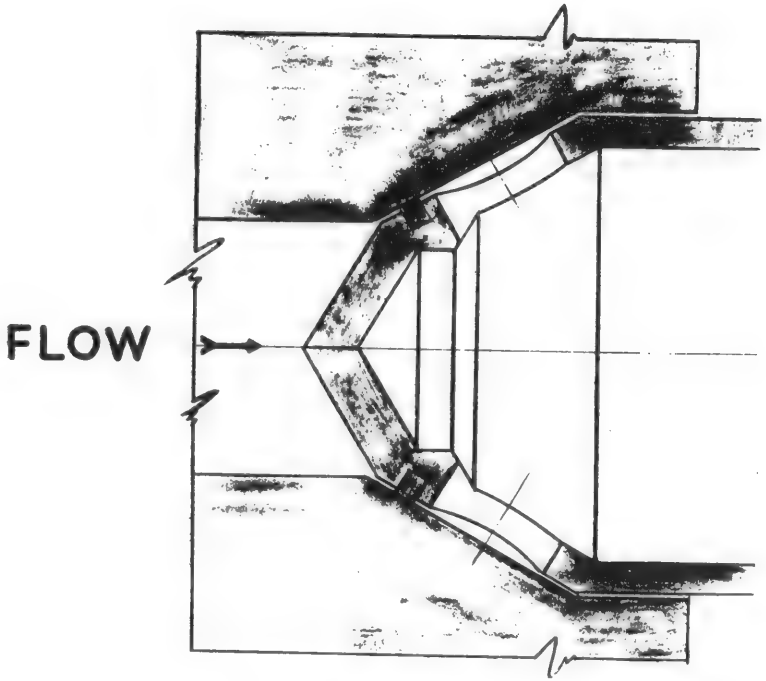


8247-472-035-3

FUEL DUAL-CHECK VALVE



FUEL DUAL CHECK VALVE



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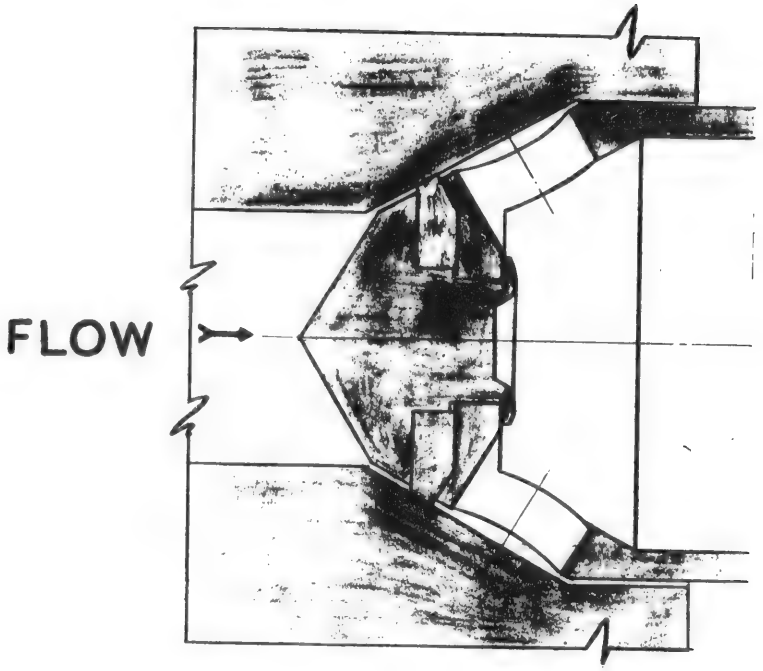
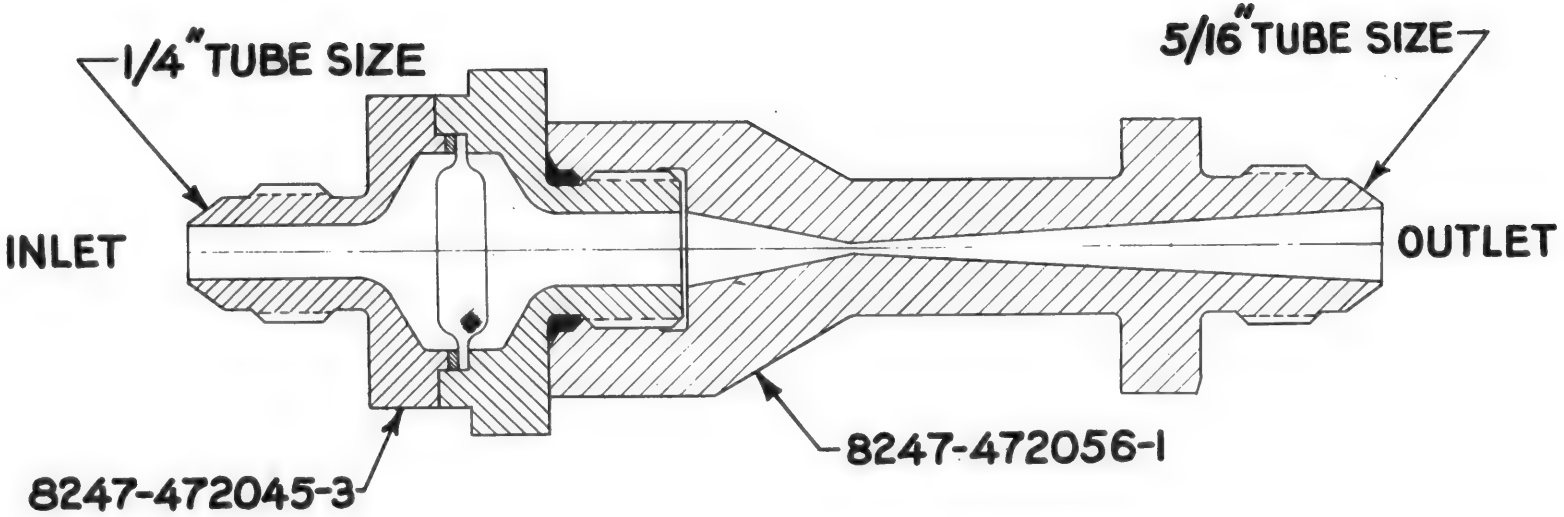


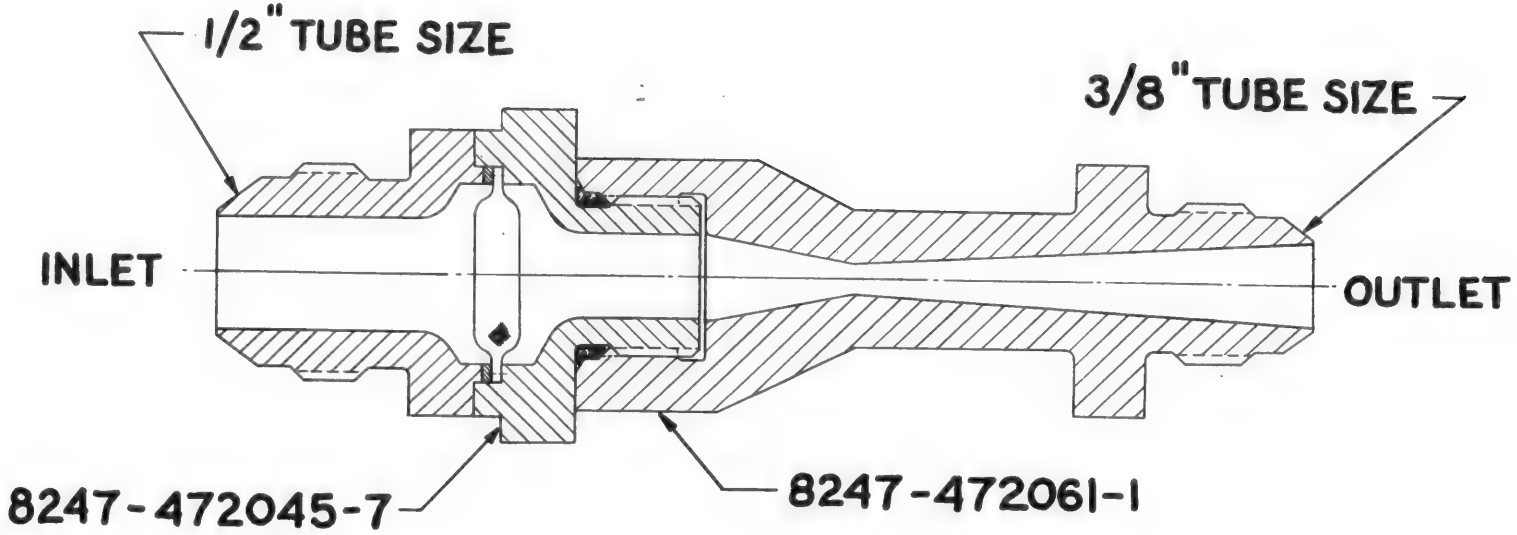
8247-472-040-5

OXIDIZER VENTURI & FILTER ASSEMBLY



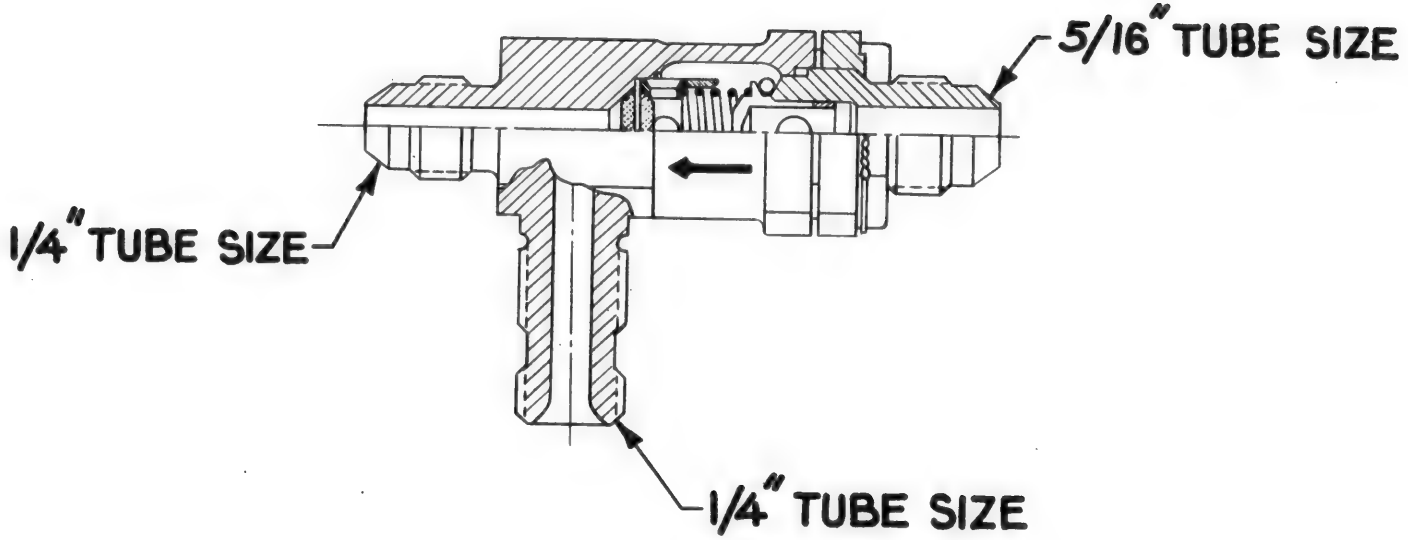
8247-472055-1

FUEL VENTURI & FILTER ASSEMBLY



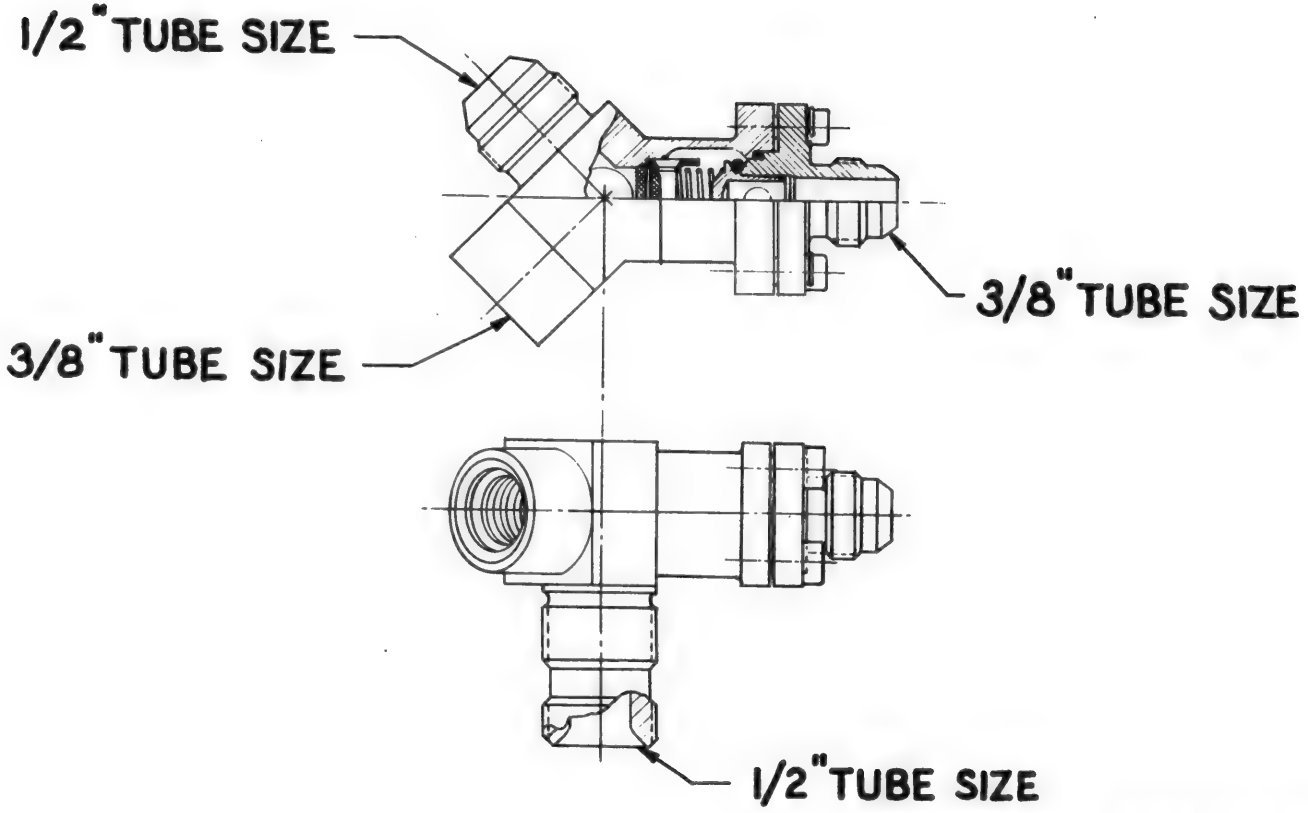
8247-472060-1

OXIDIZER FILL & DRAIN VALVE



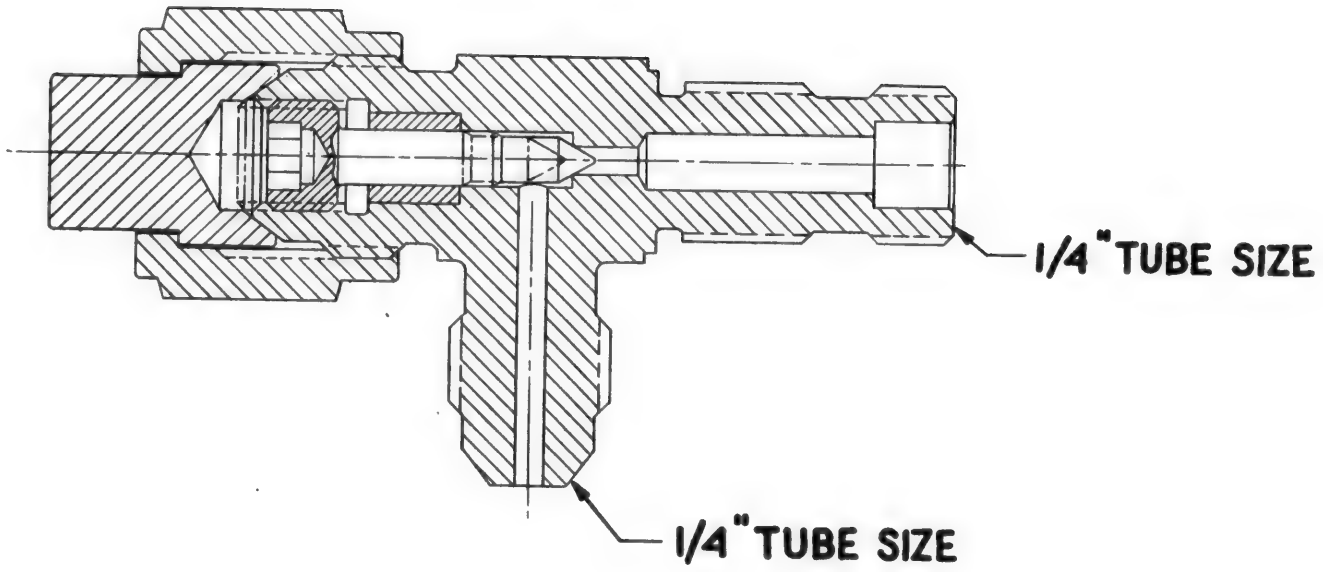
8247-472065-1

FUEL FILL & DRAIN VALVE



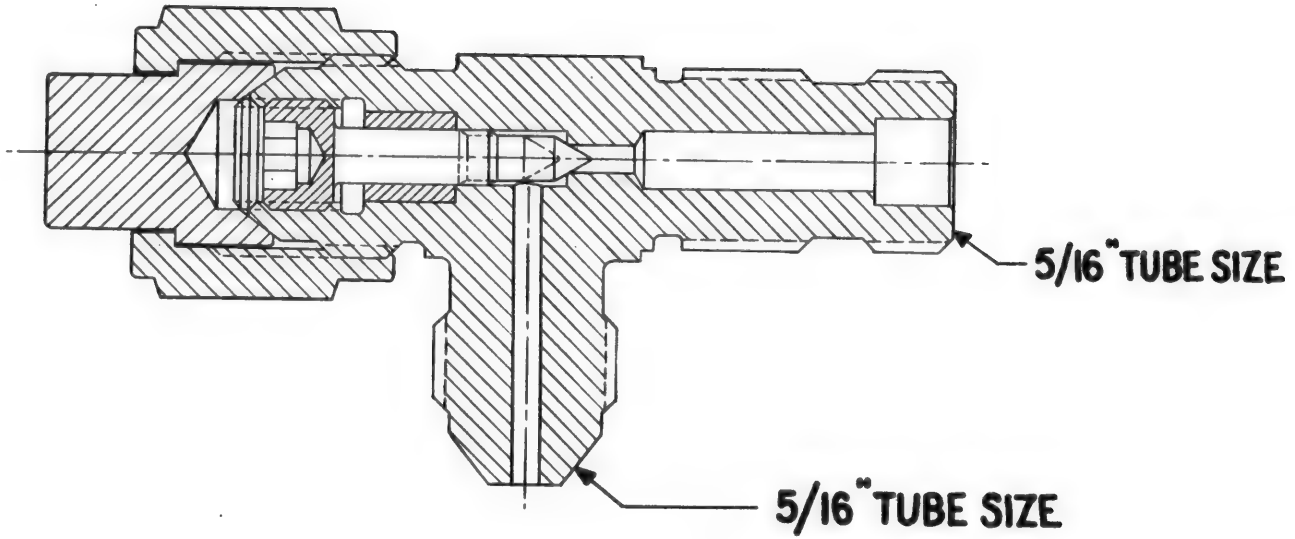
8247-472070-1

OXIDIZER BLEED VALVE



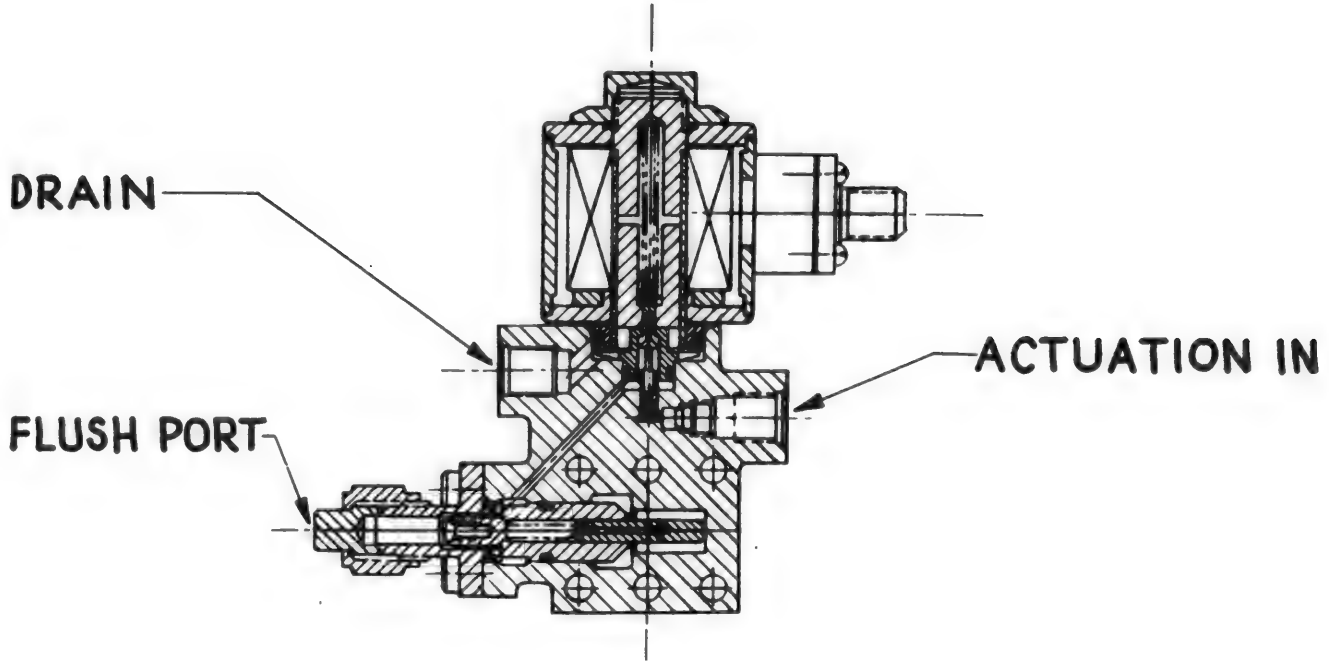
8247-472075-1

FUEL BLEED VALVE



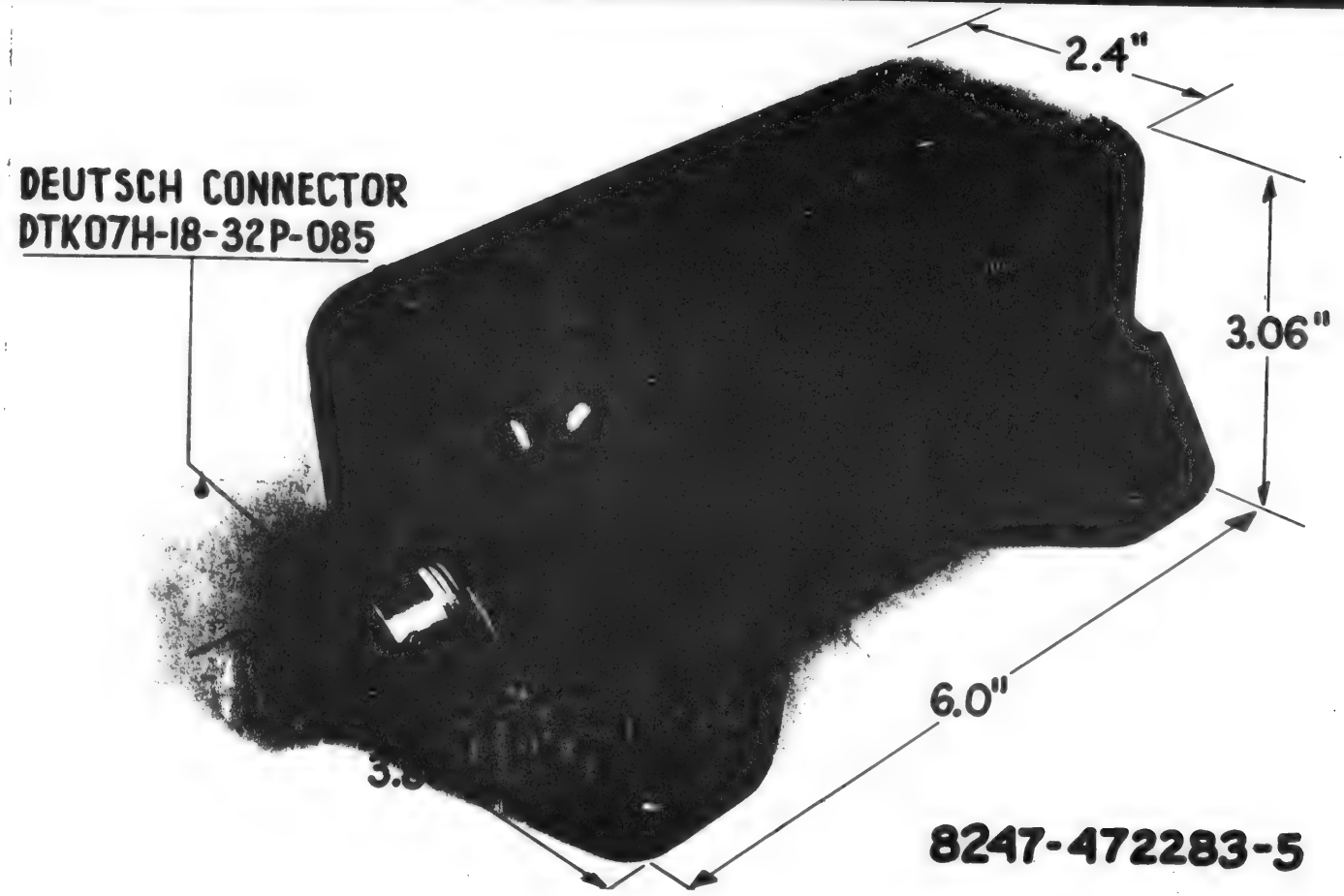
8247-472-080-1

PILOT OPERATED SOLENOID VALVE

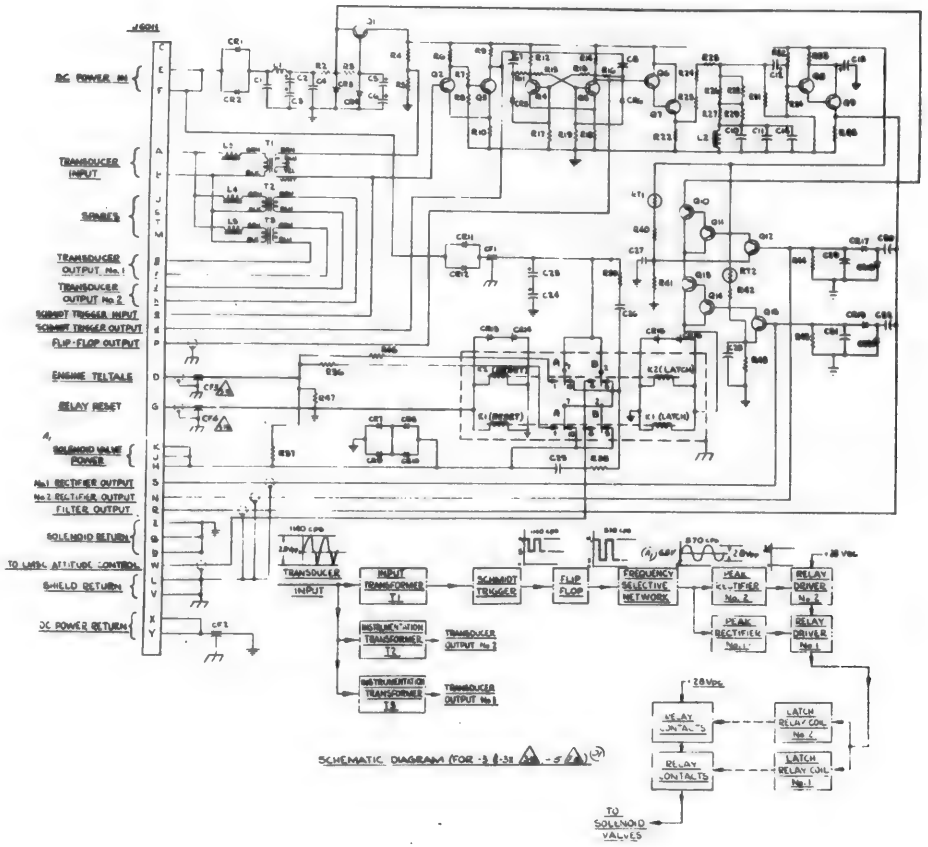


8247-472015-3

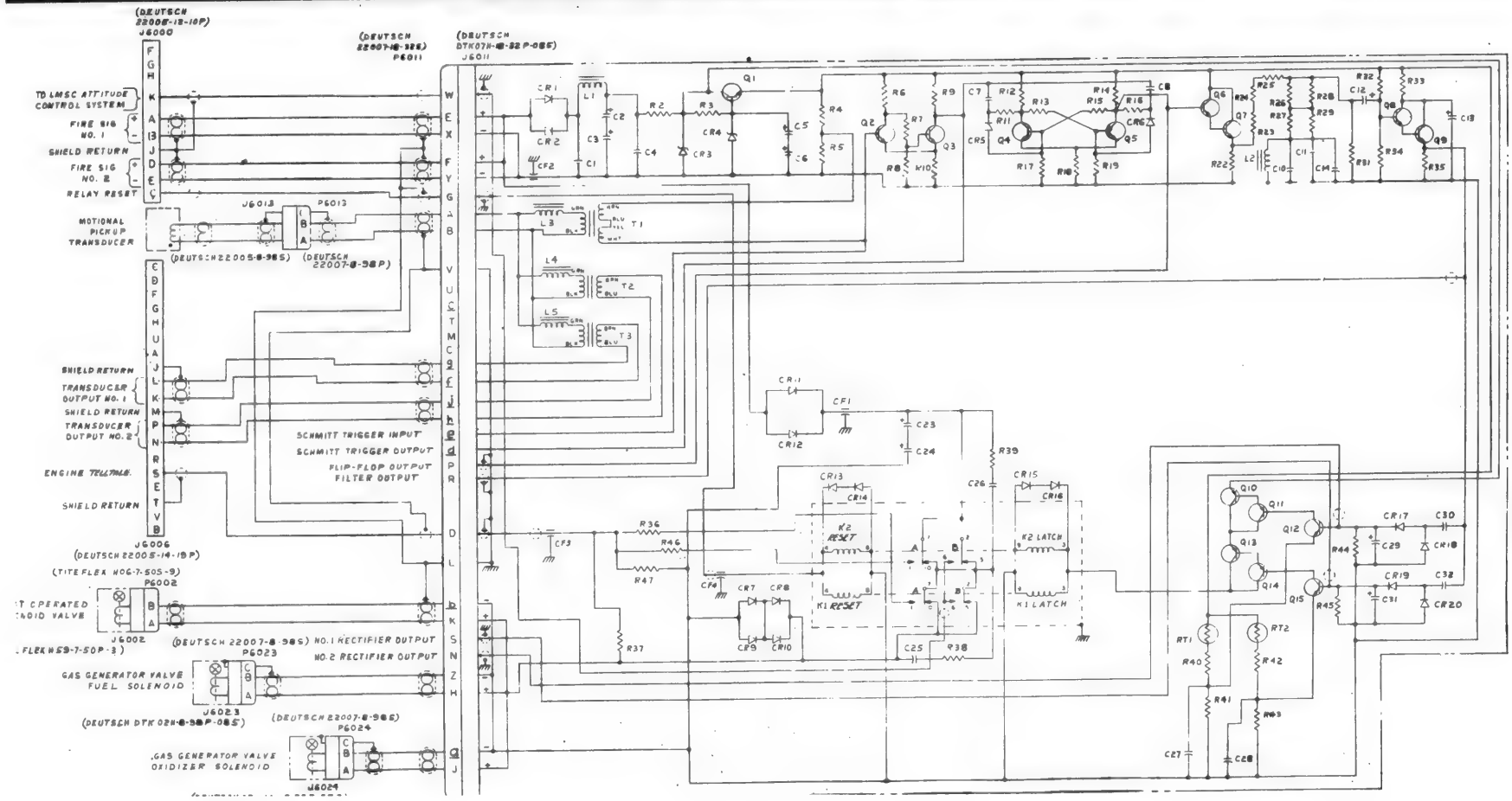
ELECTRONIC GATE ASSEMBLY



SCHEMATIC DIA. ELECTRONIC GATE



SCHEMATIC DIA. ELECTRICAL SYSTEM



GEMINI AGENA TARGET VEHICLE

SECONDARY PROPULSION SYSTEM

BAC MODEL 8250

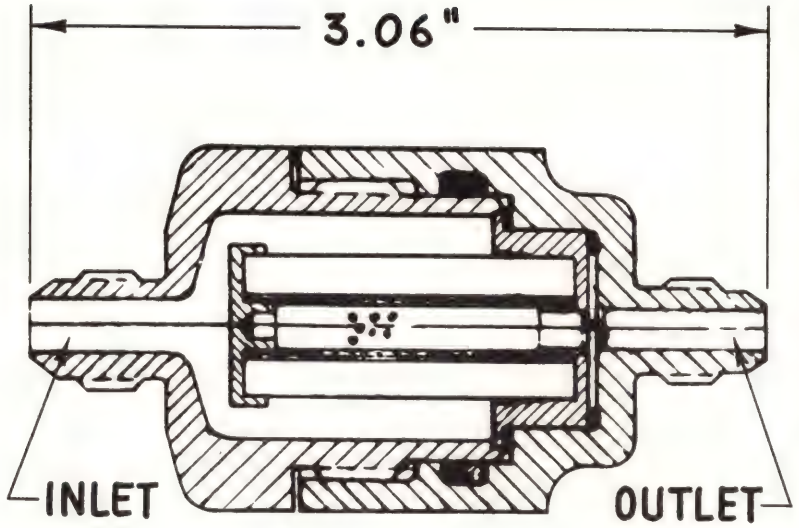
NITROGEN GAS FILTER

TYPE AND DESCRIPTION	IN-LINE, PLEATED CYLINDRICAL, 5/15 MICRON ELEMENT
PRIMARY FUNCTION	TO PREVENT CONTAMINATION, LARGER THAN 15 MICRON (APPROX .0006) FROM ENTERING THE SYSTEM
PART NUMBER	8101-472155-1
TYPE OF TESTS	COMPONENT DEVELOPMENT TESTS
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	COMPONENT PFRT
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	TEARDOWN INSPECTION REVEALED AN OPEN GASKET JACKET, EXPOSING THE ASBESTOS

NITROGEN GAS FILTER

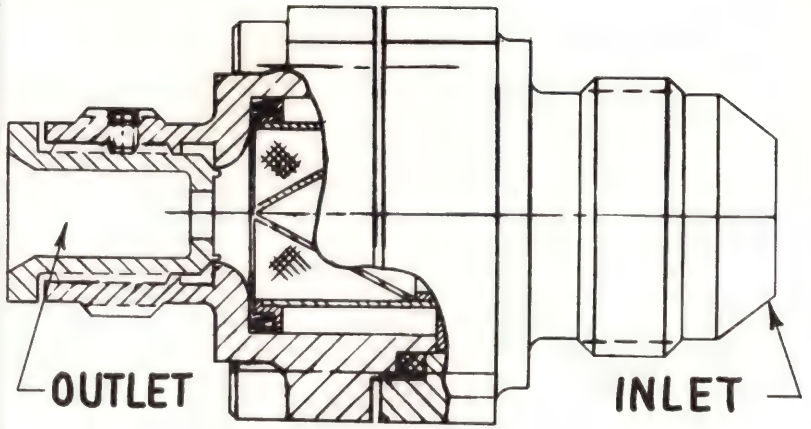
PART NUMBER	8250-472075-1
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL ; CHANGED ASBESTOS CORED GASKET TO SOLID ALUMINUM GASKET
TYPE OF TESTS	SYSTEM R&D TEST
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	SYSTEM PFRT
PROBLEMS SINCE QUALIFICATION	NONE

GAS FILTER



8250-472075-1

PROPELLANT FILTER - UNIT II



8250-472010-11

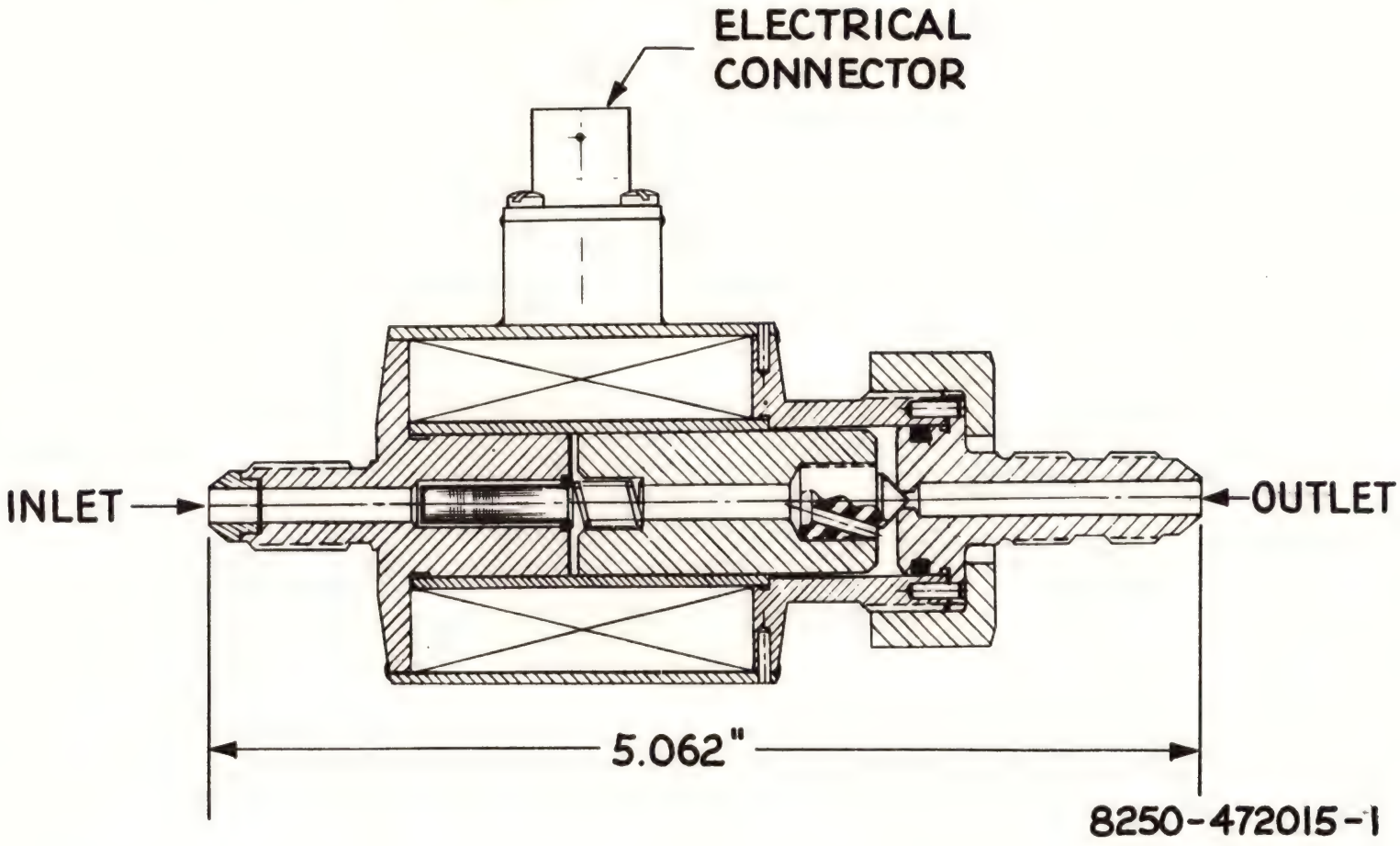
START VALVE

TYPE AND DESCRIPTION	SOLENOID, COAXIAL, NORMALLY CLOSED
PRIMARY FUNCTION	STARTS AND STOPS THE FLOW OF SOURCE GAS PRESSURE
PART NUMBER	8101-472025-1
TYPE OF TESTS	COMPONENT DEVELOPMENT TESTS
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	COMPONENT PFRT
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	OUTER SURFACE INDICATED SLIGHT RUST NO CORRECTIVE ACTION TAKEN

START VALVE

PART NUMBER	8250-472015-1
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL ; INCREASED NICKEL PLATING AND CONTROLLED POROSITY
TYPE OF TESTS	SYSTEM R & D TESTS
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATIONS	SYSTEM PFRT
PROBLEMS SINCE QUALIFICATION	START VALVE FROM ONE PVA SYSTEM AT SCTB SHOWED EXCESSIVE EXTERNAL RUST

START VALVE



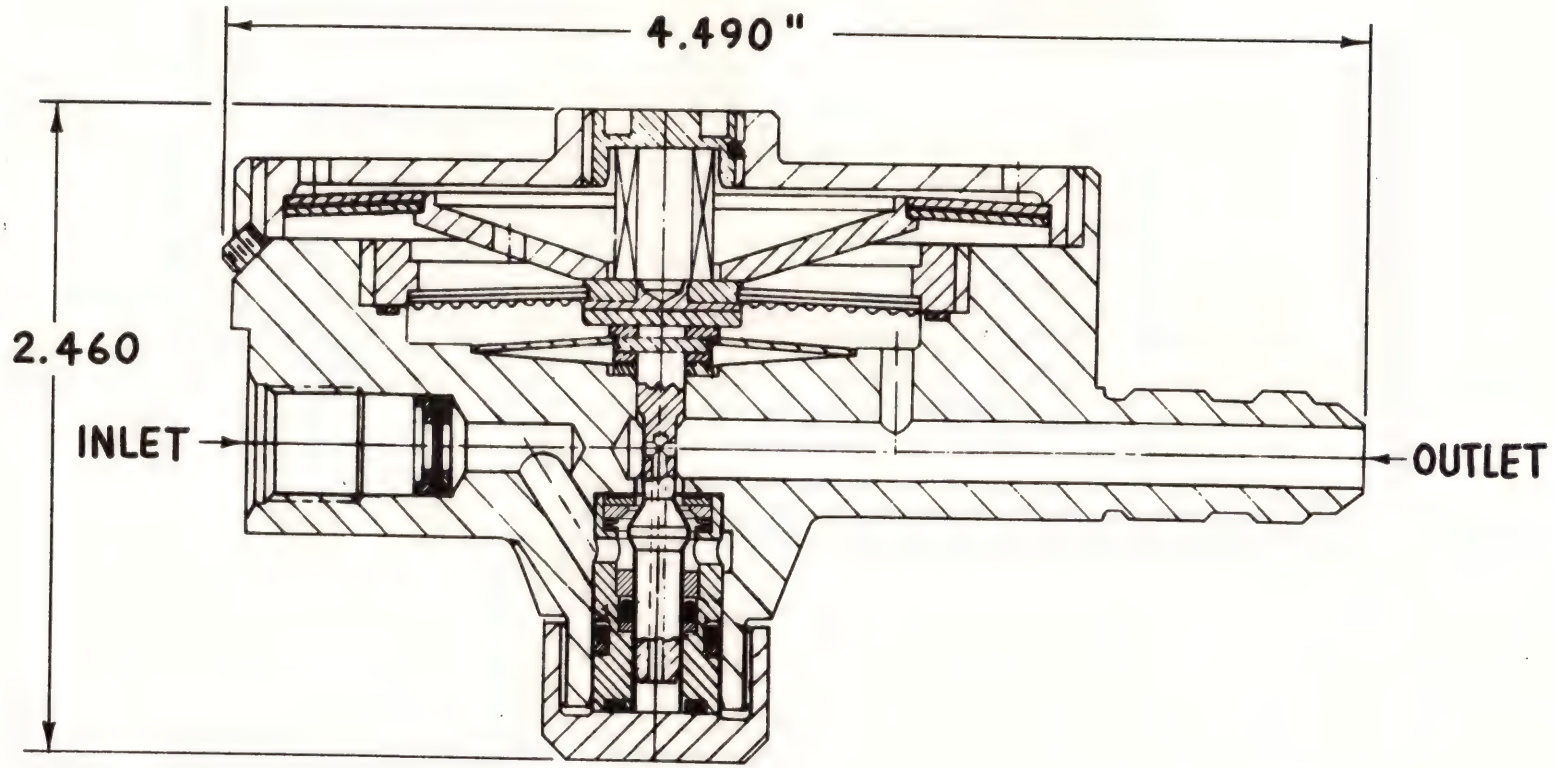
NITROGEN GAS REGULATOR

TYPE AND DESCRIPTION	SINGLE STAGE REGULATOR, SPRING LOADED DOME
PRIMARY FUNCTION	TO CONVERT VARYING SOURCE GAS PRESSURE TO REGULATED PRESSURES
PART NUMBER	8101-472030-1
TYPE OF TESTS	COMPONENT DEVELOPMENT TESTS
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATIONS	COMPONENT PFRT — THE UNIT FAILED TO MEET HOT TEST REQUIREMENTS
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	NONE

NITROGEN GAS REGULATOR

PART NUMBER	8250-472065-5
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL; SEAT HEAT STABILIZATION; CONTROLLED SEAT TORQUE
TYPE OF TESTS	a. COMPONENT DYNAMIC TO 8101 LEVELS b. SYSTEM R & D
PROBLEMS AND CORRECTIONS	a. DOME SPRING ADJUSTING SCREW INADVERTENTLY MOVED; ADDED LOCKING DEVICE b. COLD FLOW OF SEAT; PROPOSED DESIGN CHANGE
QUALIFICATION	SYSTEM PFRT
PROBLEMS SINCE QUALIFICATION	FAILURES ON PVA AT SCTB (1) 1 UNIT FAILED AT LOCK-UP WITH 4000 PSIG INLET (2) 1 UNIT REGULATED SLIGHTLY HIGH OUT OF SPEC AT LOW FLOW; AUTHORIZED SEAT REDESIGN, 1 UNIT IN INFORMAL QUAL TEST INCLUDING HOT, COLD, DYNAMIC, & 6-MONTH STORAGE TEST

GAS PRESSURE REGULATOR



8250-472065-1

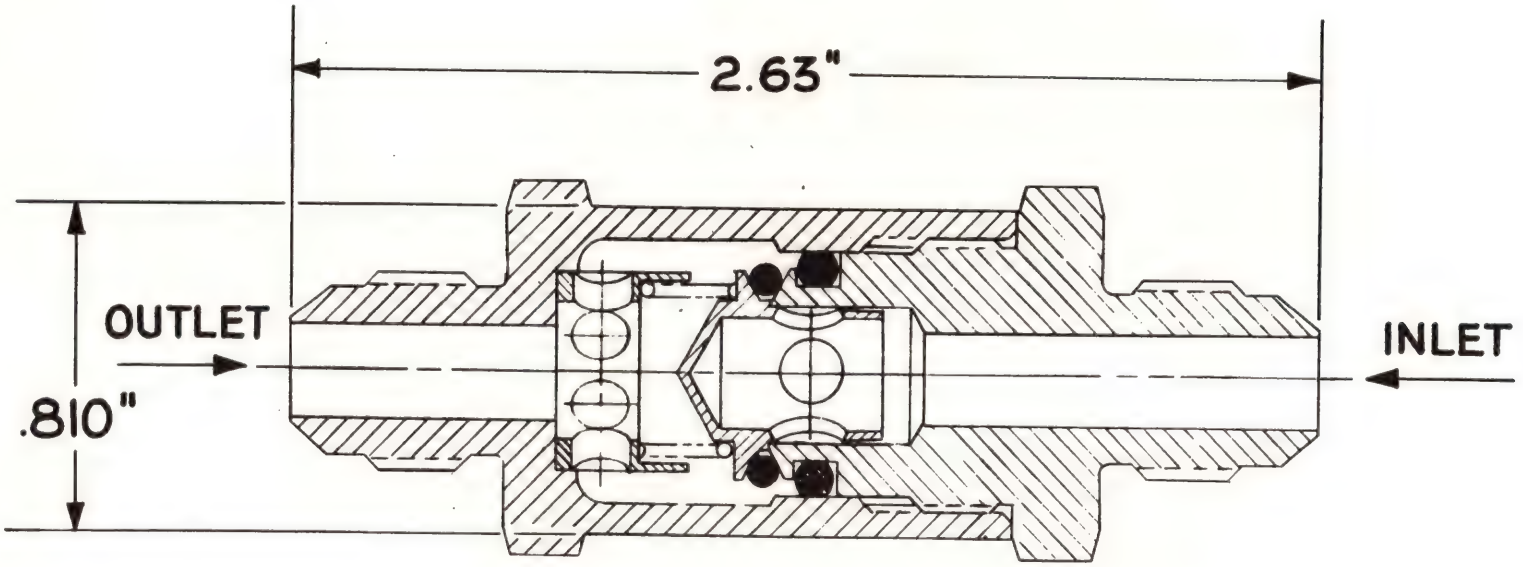
NITROGEN GAS CHECK VALVE

TYPE AND DESCRIPTION	CIRCLE SEAL RUBBER "O" RING
PRIMARY FUNCTION	USED TO MAINTAIN TANK PRESSURE
PART NUMBER	8101-472080-3
TYPE OF TESTS	COMPONENT DEVELOPMENT TESTS
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATIONS	COMPONENT PFRT
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	NONE

NITROGEN GAS CHECK VALVE

PART NUMBER	8250-472090-1
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL
TYPE OF TESTS	SYSTEM R & D
PROBLEMS AND CORRECTIONS	SUSPECTED CRACKING PRESSURE PROBLEM; CHANGED PROCEDURES
QUALIFICATIONS	SYSTEM PFRT
PROBLEMS SINCE QUALIFICATION	NONE

GAS CHECK VALVE



8250-472090-1

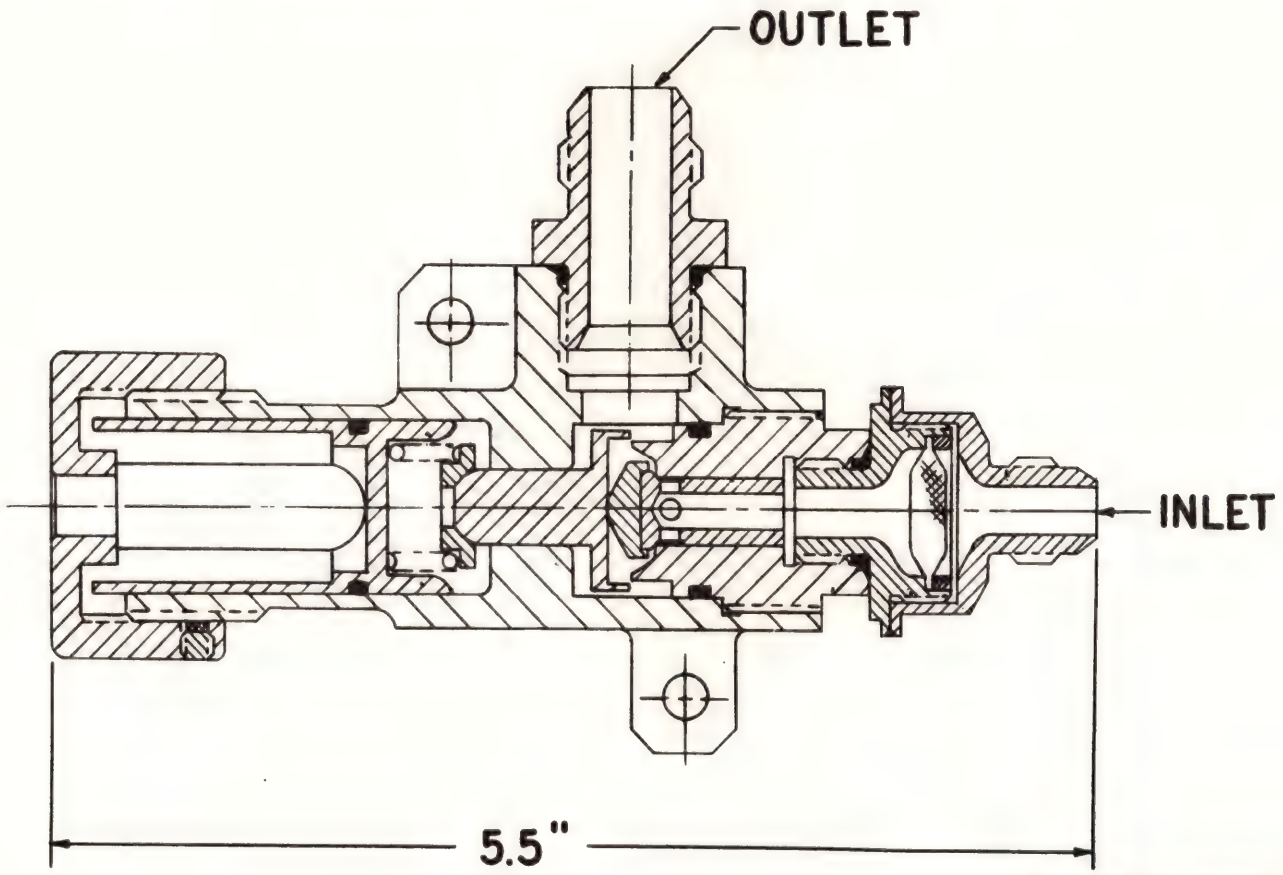
NITROGEN GAS RELIEF VALVE

TYPE AND DESCRIPTION	DIRECT SPRING-LOADED POPPET, EXTERNAL ADJUSTING TYPE
PRIMARY FUNCTION	TO RELIEVE GAS PRESSURE BUILD UP DUE TO THERMAL CONDITIONS AND REGULATOR MALFUNCTION
PART NUMBER	8101-472170-3
TYPE OF TESTS	COMPONENT R&D 1000 CYCLES
PROBLEMS AND CORRECTIONS	FAILED DYNAMIC TEST ; SPRING WAS REDESIGNED
QUALIFICATION	COMPONENT PFRT ; LEAKED DURING DYNAMIC TEST
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	NONE

NITROGEN GAS RELIEF VALVE

PART NUMBER	8250-472060-1
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL; CHANGED OUTLET PORT TO ½ TUBE SIZE; DELETED TEST PORT
TYPE OF TESTS	SIMULATED SYSTEM REGULATOR MALFUNCTION SYSTEM R&D
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	SYSTEM PFRT - UNIT WAS READJUSTED
PROBLEMS SINCE QUALIFICATION	ADDED SET SCREW TORQUE AND TORQUE STRIPE REQUIREMENT

GAS PRESSURE RELIEF VALVE



8250-472060-1

48

3-WAY VALVE

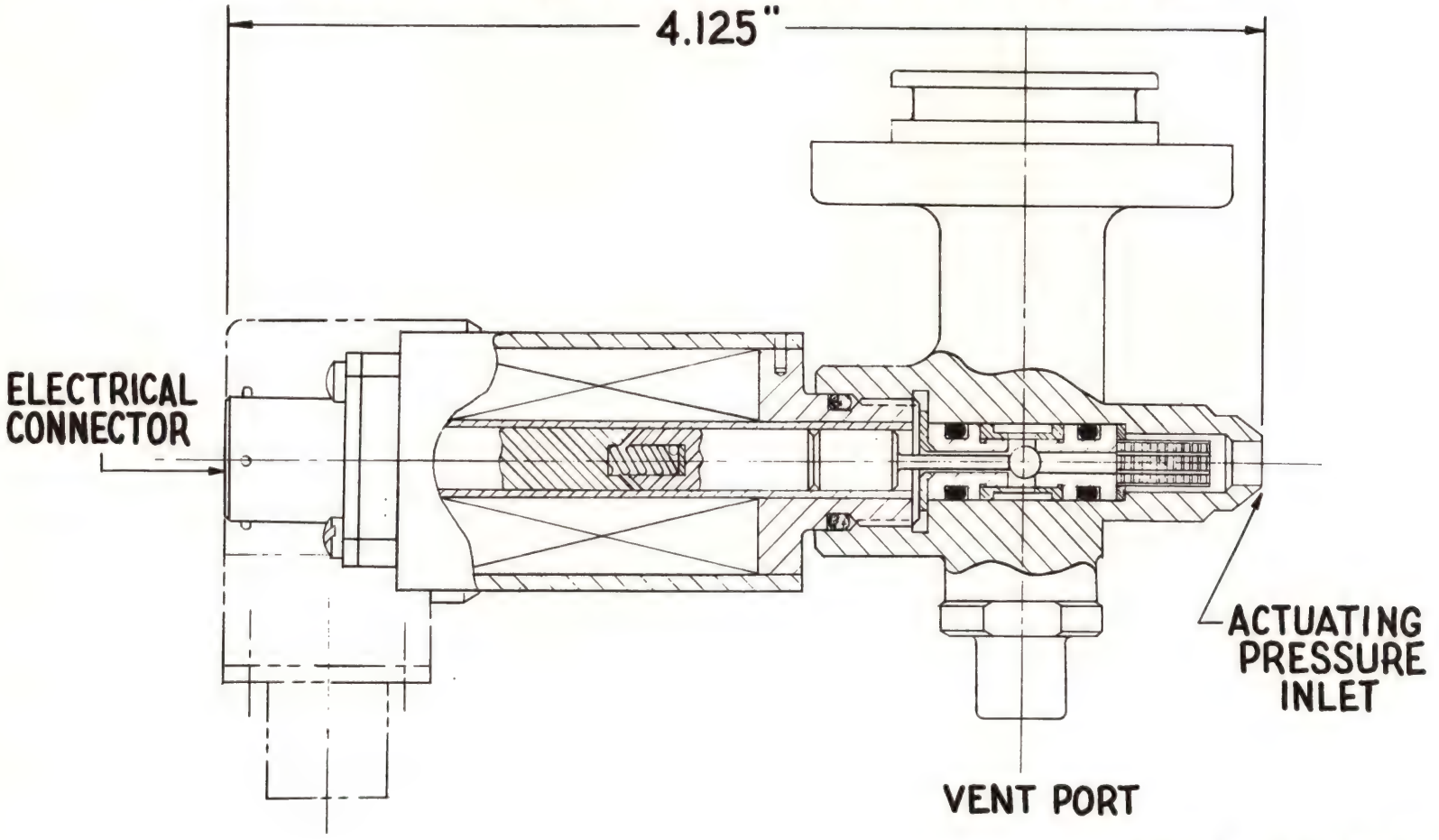
TYPE AND DESCRIPTION	SOLENOID ACTUATED, NORMALLY CLOSED
PRIMARY FUNCTION	TO OPEN AND CLOSE THE PROPELLANT VALVE
PART NUMBER	8101-472055-5 (UNIT II) 8101-472055-7 (UNIT I)
TYPE OF TESTS	COMPONENT R&D 10,000 CYCLES
PROBLEMS AND CORRECTIONS	LEAKAGE DURING VIBRATION
QUALIFICATION	COMPONENT PFRT
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	SLIGHT RUST ON OUTER COIL HOUSING

3-WAY VALVE

PART NUMBER	8250-472045-11 (UNIT I) -33 (UNIT II)
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL; ADDED FILTER AT VENT PORT; ADDED HEAVIER NICKEL PLATE & CONTROLLED POROSITY
TYPE OF TESTS	R&D DYNAMIC TEST OF VENT FILTER UNIT ONLY TO 8101 LEVELS; SYSTEM R&D (ON TCA)
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	SYSTEM PFRT (ON TCA)
PROBLEMS SINCE QUALIFICATION	EXTERNAL RUST ON PVA UNITS AT LMSC

98

THREE WAY SOLENOID VALVE



8250-472045-1,3

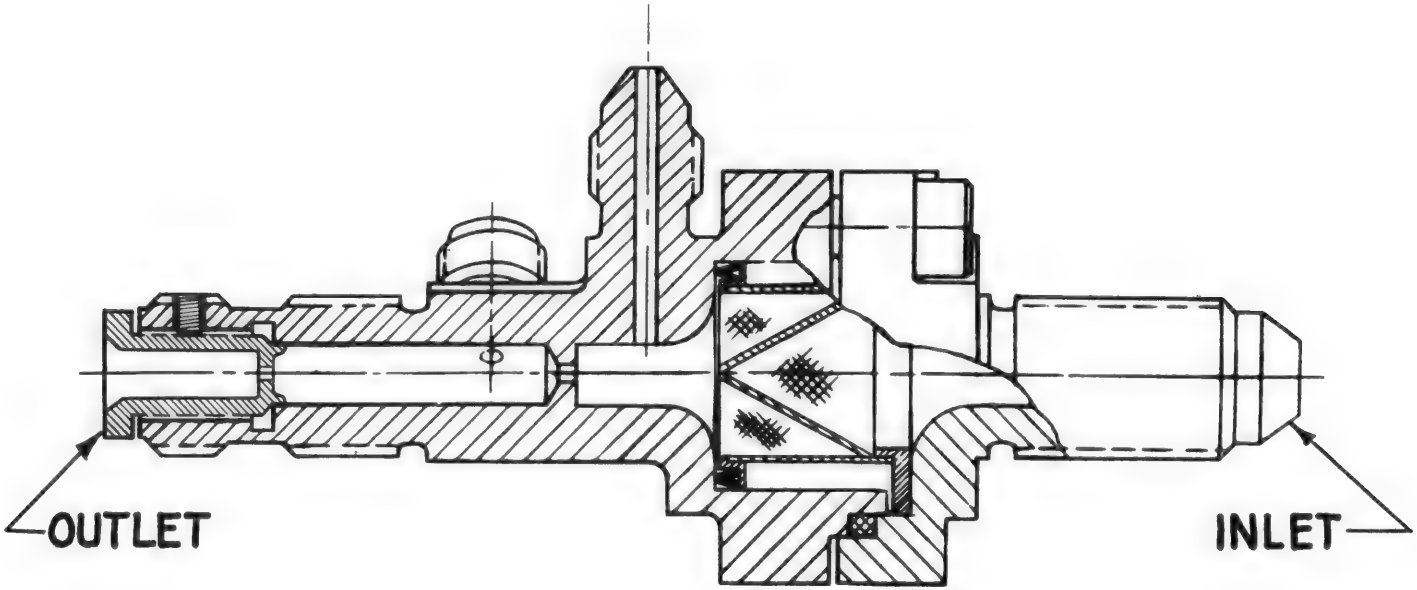
PROPELLANT VALVE INLET FILTERS

TYPE AND DESCRIPTION	25/40 MICRON "M" SHAPE FILTER ELEMENT
PRIMARY FUNCTION	TO FILTER THE PROPELLANTS FROM TANKS
PART NUMBERS	UNIT I 8101-472126-1 OXIDIZER UNIT I 8101-472126-3 FUEL UNIT II 8101-472125-3 OXIDIZER & FUEL
TYPE OF TESTS	R&D TESTS ON PROP. VALVE
PROBLEMS AND CORRECTIONS	NONE
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	NONE

PROPELLANT VALVE INLET FILTER

PART NUMBER	UNIT I 8250-472010-7 OX UNIT I 8250-472010-9 FUEL UNIT II 8250-472010-11 OX & FUEL
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL; CHANGED 350 MICRON FILTER TO 25/40 AND ADDED SEAL ; UNIT II ½" T.S INLET PORT WAS ⅜" T.S.
TYPE OF TESTS	SYSTEM R & D
PROBLEMS AND CORRECTIONS	NONE
PROBLEMS SINCE QUALIFICATION	CHANGED TRIM ORIFICE CONFIGURATION TO EXPEDITE T.C. A/T

PROPELLANT FILTER - UNIT I



8250-472010-7&9

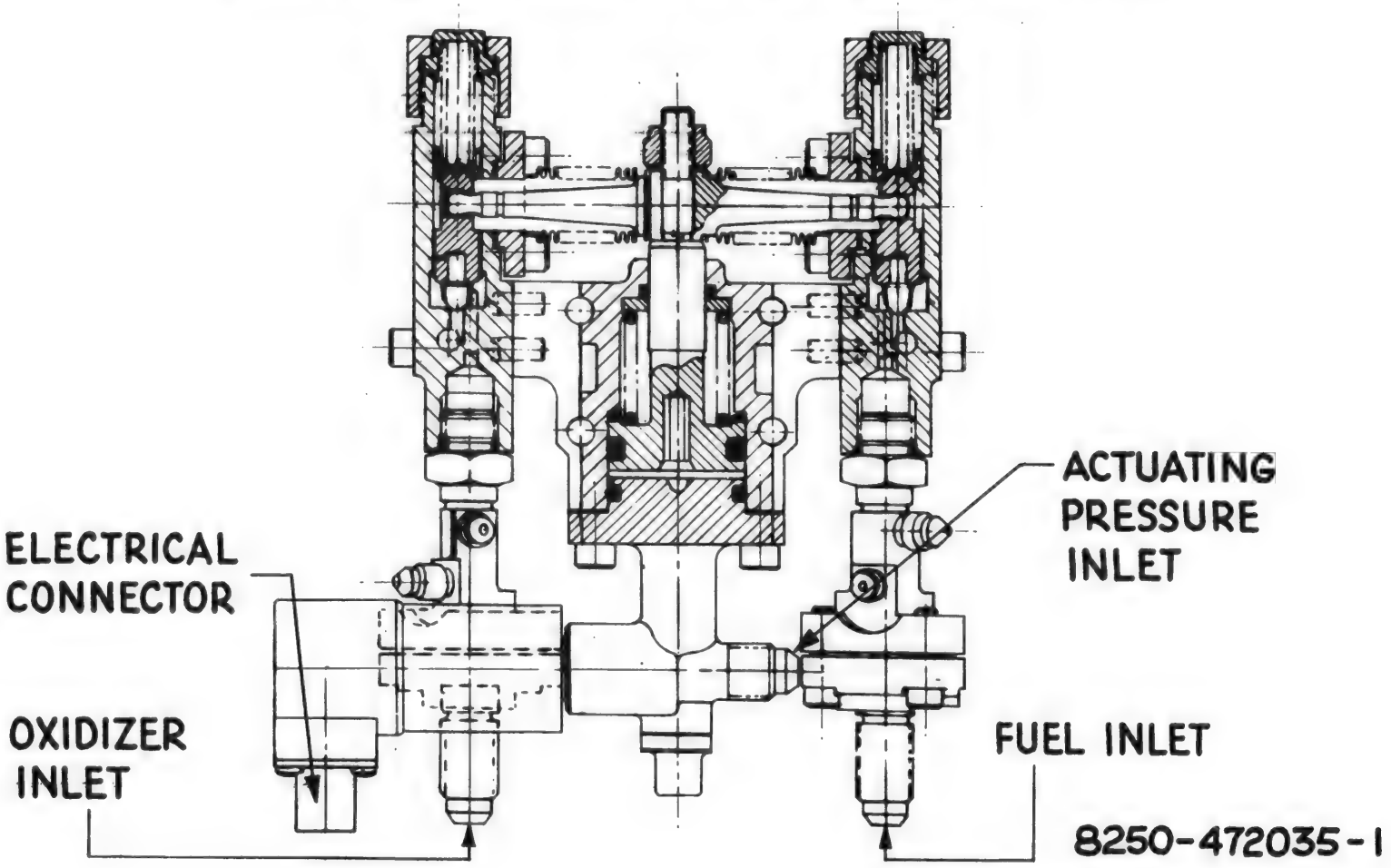
PROPELLANT VALVES

TYPE AND DESCRIPTION	YOKE TYPE, GAS ACTUATED
PRIMARY FUNCTION	TO START & STOP THE FLOW OF PROPELLANTS
PART NUMBERS	UNIT I 8101-472095-9 ; UNIT II 8101-472100-7
TYPE OF TEST	COMPONENT R & D 1000 CYCLES EACH
PROBLEMS AND CORRECTIONS	DEFORMATION OF THE KEL-F TIP ; IMPOSED LIMITATION ON UNIT II ONLY
QUALIFICATION	AT THRUST CHAMBER LEVEL ; NOTED SALTS ON OX SIDE
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	YOKE BELLOW FAILURE ; PITTING CORROSION; IMPOSED RIGID FABRICATING CONTROLS ON VENDOR

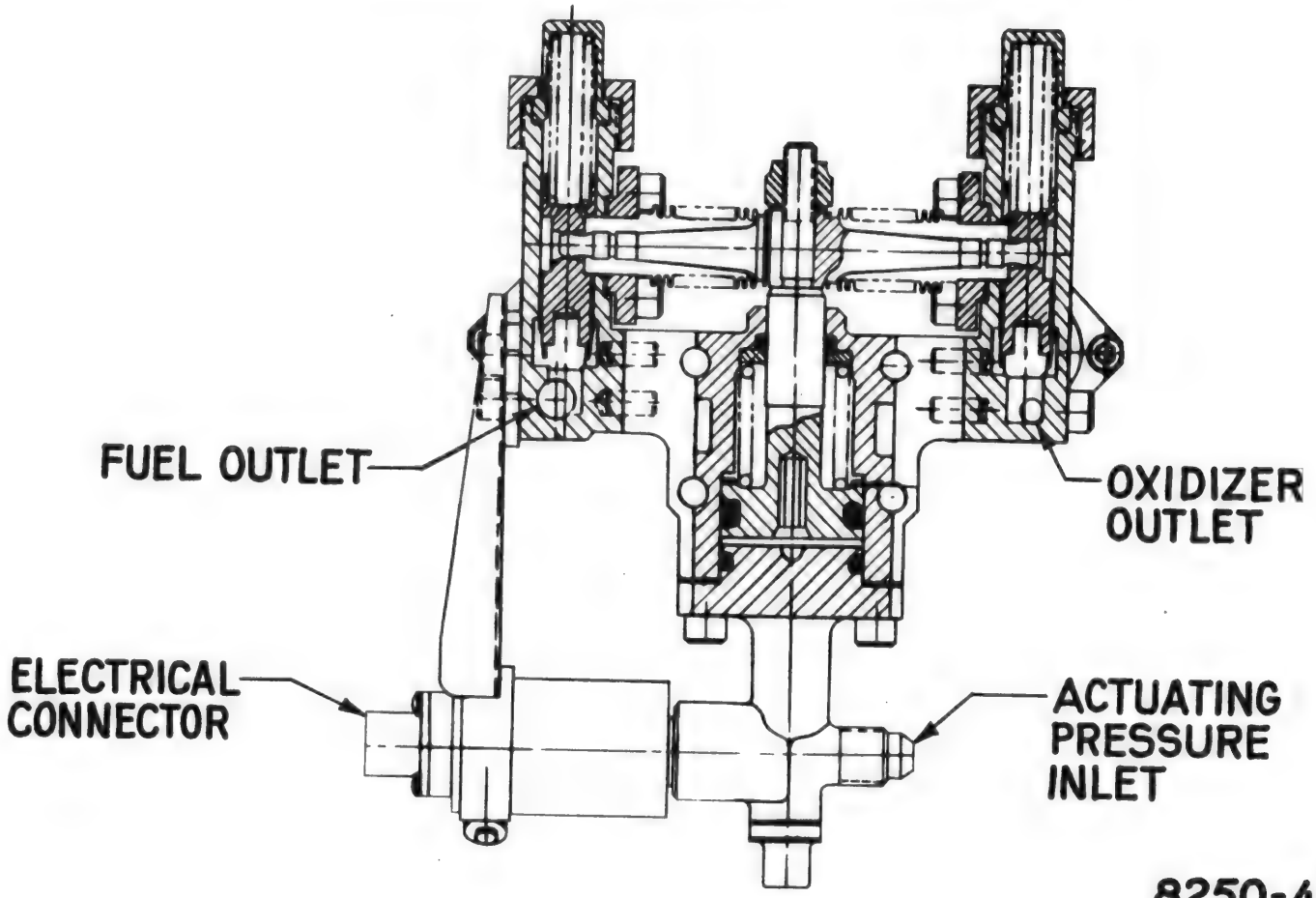
PROPELLANT VALVES

PART NUMBERS	UNIT I 8250-472035-5 UNIT II 8250-472040-5
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL; FILTERED VENT AT ACTUATING CHAMBER
TYPE OF TESTS	SYSTEM R&D
PROBLEMS AND CORRECTIONS	ADDITION OF VENT FILTERS REQUIRED INCREASE IN RESIDUAL IMPULSE
QUALIFICATION	SYSTEM PFRT; SALTS ON OXIDIZER SIDE CHANGED ALUMINUM GASKETS TO GOLD
PROBLEMS SINCE QUALIFICATION	NONE — UNIT I, ADDED BACK-UP RING AND CHANGED NUT TO LIQUID FILTER INLET CONNECTION

PROPELLANT VALVE - UNIT I



PROPELLANT VALVE - UNIT II



8250-472040-1

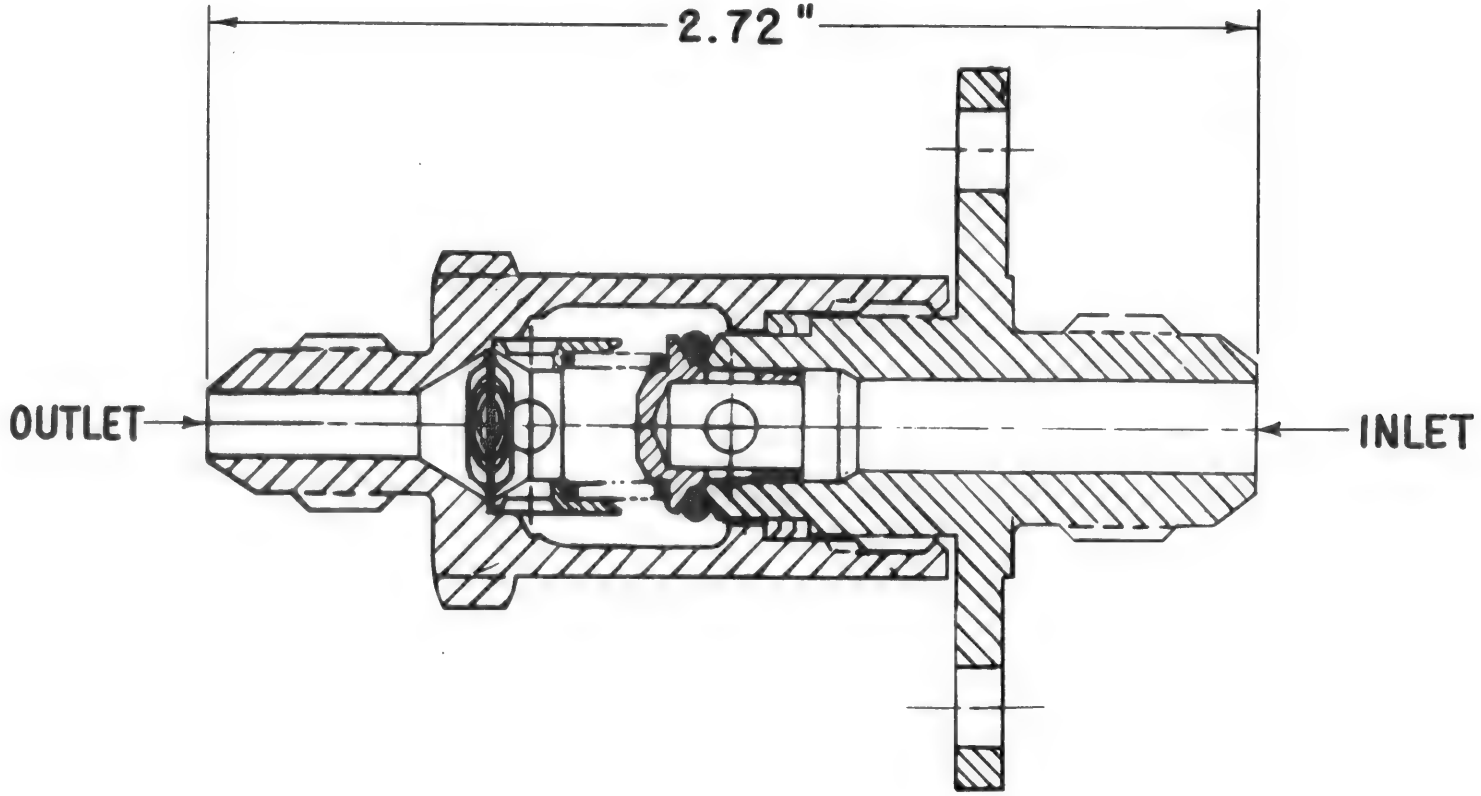
OXIDIZER FILL AND DRAIN VALVE

TYPE AND DESCRIPTION	CHECK VALVE WITH MOUNTING LUGS
PRIMARY FUNCTION	TO FILL AND DRAIN THE MON SYSTEM
PART NUMBER	8101-472045-1
TYPE OF TESTS	COMPONENT R & D 1000 CYCLES
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	COMPONENT PFRT
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	SALTING AND PITTING OF THE ALUMINUM SEALING SURFACES

OXIDIZER FILL AND DRAIN VALVE

PART NUMBER	8250-472001-3
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL; CONTROLLED STROKE; FILTER :- CHANGED TO STAINLESS STEEL UNIT AND INLET PORT TO 3/8 "T.S.
TYPE OF TESTS	COMPONENT R&D DYNAMIC TO 8101 LEVELS SYSTEM R&D
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	SYSTEM PFRT
PROBLEMS SINCE QUALIFICATION	NONE

OXIDIZER FILL VALVE



8250-472001-3

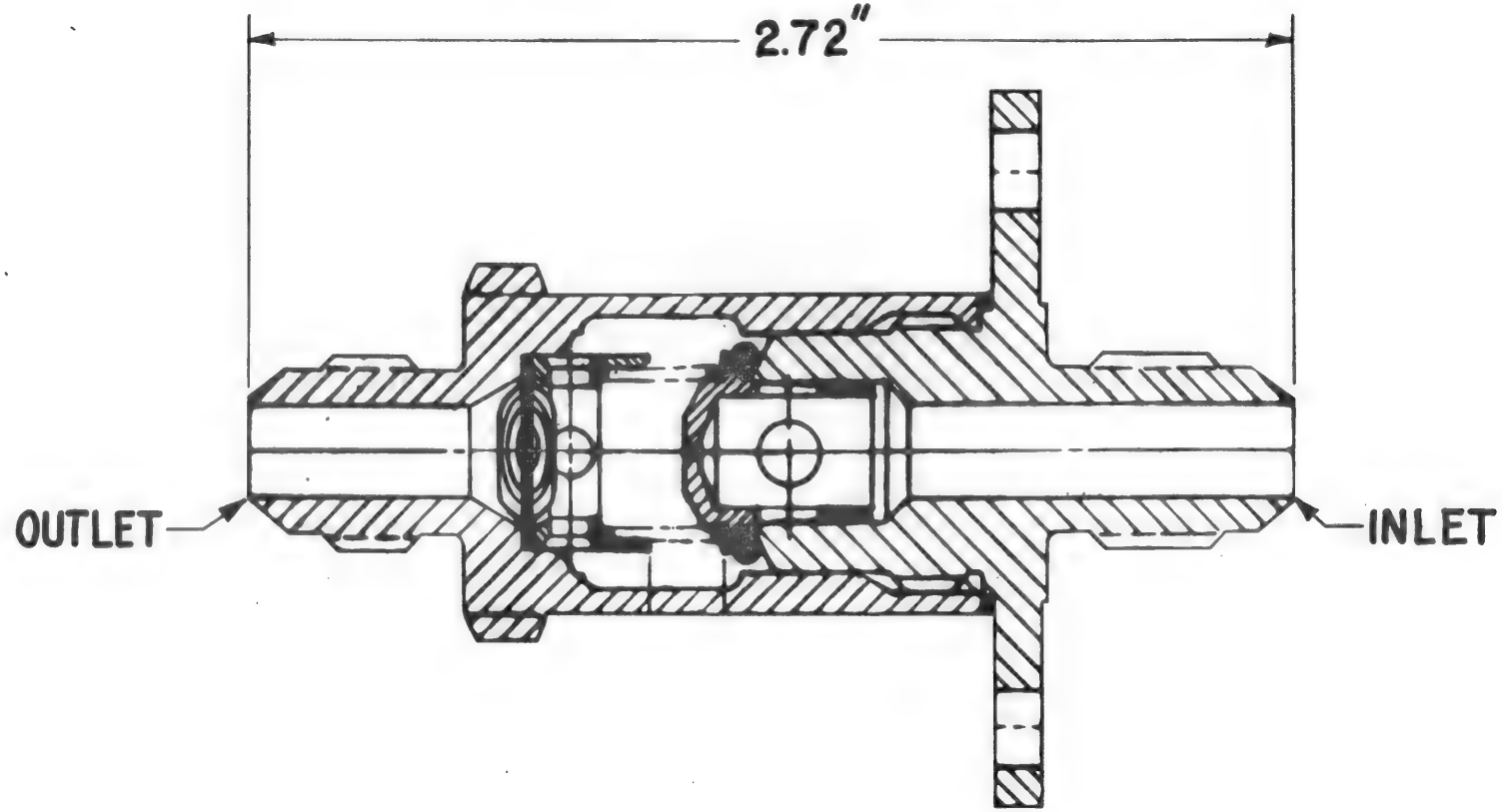
FUEL FILL AND DRAIN

TYPE AND DESCRIPTION	CHECK VALVE WITH MOUNTING LUGS
PRIMARY FUNCTION	TO FILL AND DRAIN UDMH SYSTEM
PART NUMBER	8101-472050-3
TYPE OF TESTS	COMPONENT R&D (-1 TEFLON "O" RING) 1000 CYCLES
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	COMPONENT PFRT (-1 TEFLON 'O' RING)
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	FAILED GAS LEAK CHECK; CHANGED TEFLON 'O' RING TO BUTYL RUBBER

FUEL FILL AND DRAIN VALVE

PART NUMBER	8250-472005-5
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL; CONTROLLED STROKE; FILTER
TYPE OF TESTS	COMPONENT R&D DYNAMIC TO 8101 LEVELS SYSTEM R&D
PROBLEMS AND CORRECTIONS	VALVE HANG-UP; EVALUATED OTHER RUBBER COMPOUNDS
QUALIFICATION	SYSTEM PFRT WITH MODIFIED ALUMINUM VALVE
PROBLEMS SINCE QUALIFICATION	CHANGED TO ALL STAINLESS VALVE WITH "O" RING SAME AS OX VALVE. CONSIDERED QUALIFIED BY SIMILARITY

FUEL FILL VALVE



8250-472005-3

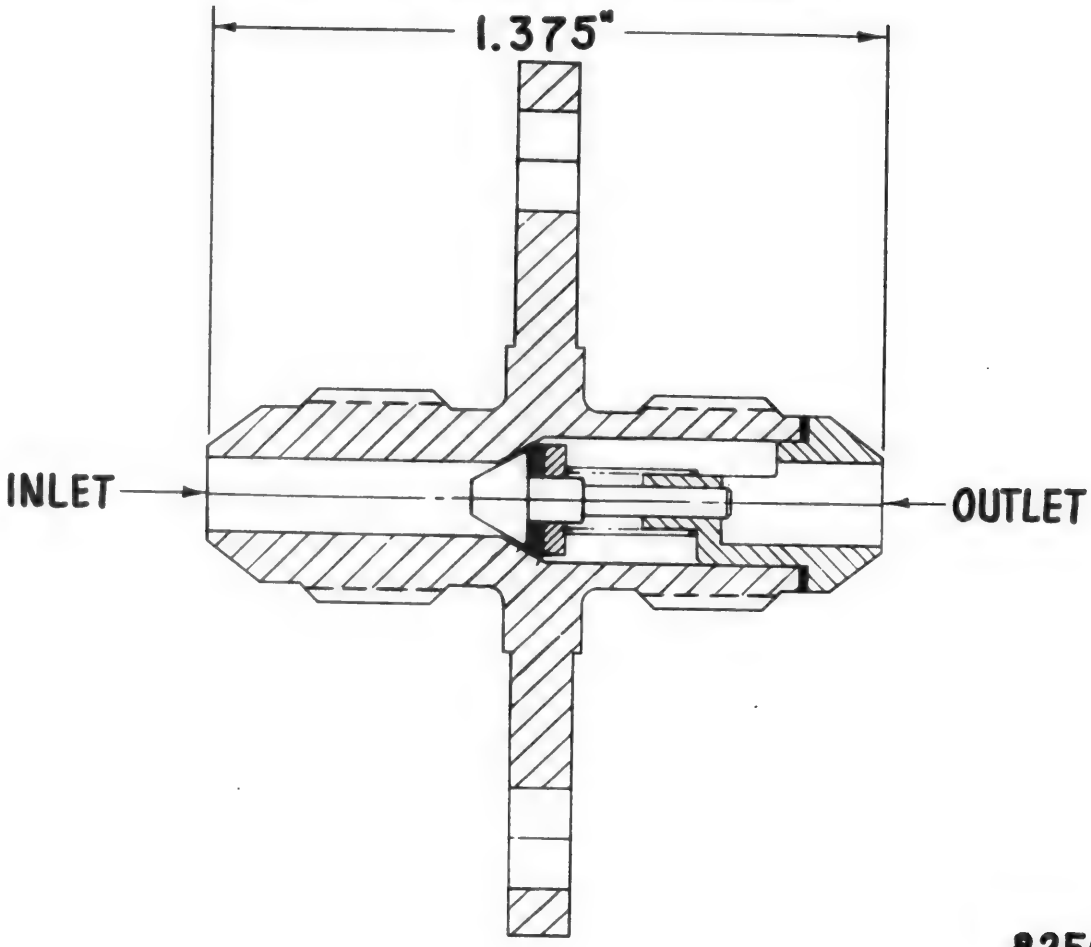
NITROGEN GAS FILL AND VENT VALVE

TYPE AND DESCRIPTION	CHECK VALVE, SIMILAR TO AN815-4 UNION, EXCEPT HAS MOUNTING FLANGES. ALL STAINLESS STEEL; NYLON SEAL
PRIMARY FUNCTION	USED TO PRESSURIZE AND VENT THE SOURCE BOTTLE IN CONJUNCTION WITH A MANUALLY OPERATED, POPPET UNSEATING TOOL, FROM THE GROUND SERVICE CONSOLE. CAPPED WITH REDUNDANT SEAL FOR FLIGHT.
PART NUMBER	8101-472020-3
TYPE OF TESTS	COMPONENT DEVELOPMENT TESTS ON -1
PROBLEMS AND CORRECTION	RUBBER "O" RING DISLODGED FROM POPPET ON VENT CYCLE (-1 VALVE): CHANGED TO NYLON SEAL AND CONTROLLED POPPET STROKE (-3 VALVE)
QUALIFICATION	COMPONENT PFRT (-1). PENALTY PFRT ON -3 20 HIGH PRESSURE FILL AND VENT CYCLES
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	NONE

NITROGEN GAS FILL AND VENT VALVE

PART NUMBER	8250-472070-1
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL
TYPE OF TESTS	SYSTEM R&D TESTS
PROBLEMS AND CORRECTIONS	VALVE WAS INSTALLED IN REVERSE: ADDED NOTCH ON FLANGE TO MATE WITH PIN ON SERVICE PANEL. EXPERIENCED VALVE HANG-UP: VENDOR QUALITY INSTRUCTED TO INSPECT FOR NYLON SHREADS, METAL CHIPS, BURRS, AND FINISHES WHICH COULD CAUSE HANG-UP AND LEAKS
QUALIFICATION	SYSTEM PFRT
PROBLEMS SINCE QUALIFICATION	NONE

GAS FILL VALVE



8250-472070-1

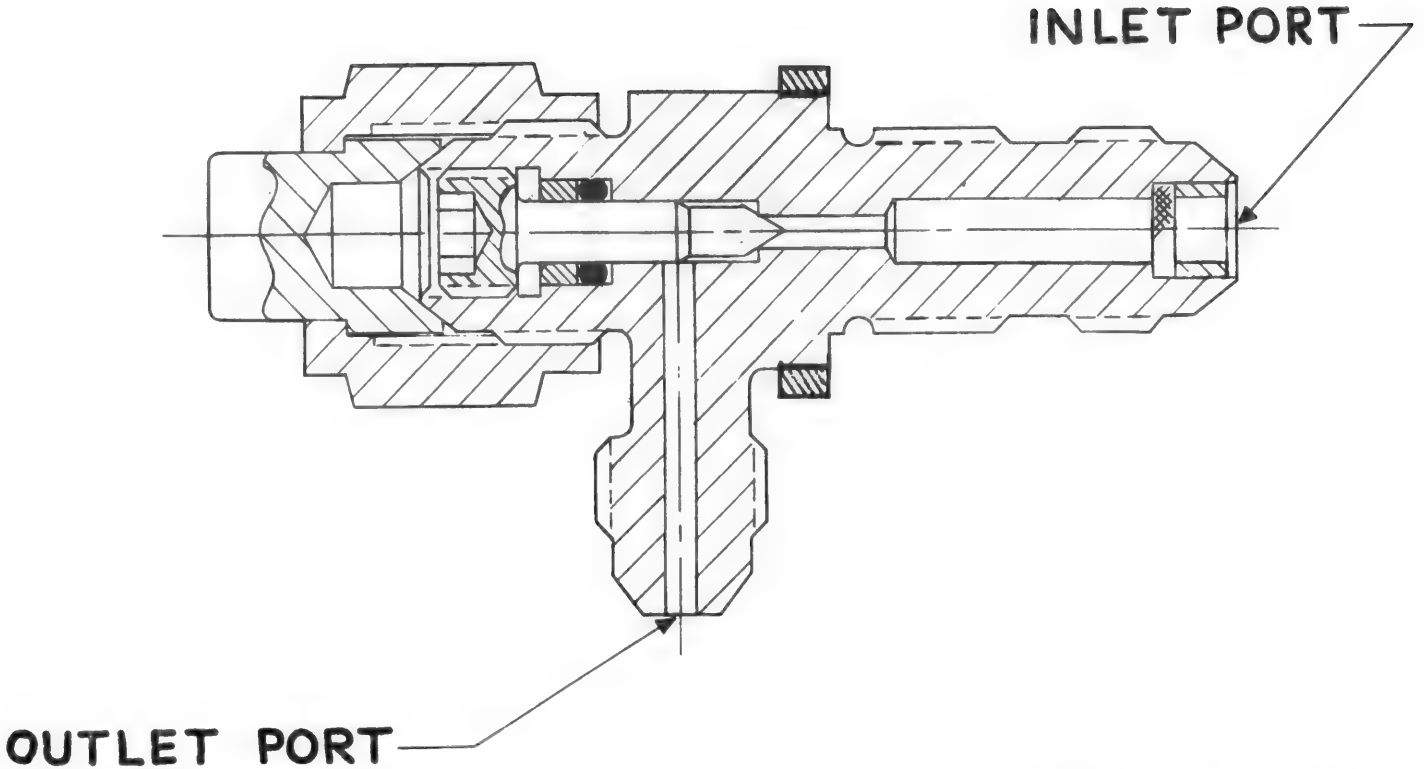
MANUAL GAS VALVE

TYPE AND DESCRIPTION	STAINLESS STEEL, METAL TO METAL NEEDLE VALVE SEAT
PRIMARY FUNCTION	USED TO MAINTAIN POSITIVE PRESSURE ON PROPELLANT TANK IN CONJUNCTION WITH GSE CONSOLE
PART NUMBER	8101-472075-1
TYPE OF TESTS	COMPONENT R & D 1000 CYCLES ENDURANCE
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	COMPONENT PFRT
FLIGHT HISTORY	NO KNOWN PROBLEMS
PROBLEMS SINCE QUALIFICATION	NONE

MANUAL GAS VALVE

PART NUMBER	8250-472050-5
TYPE OF CHANGES FROM 8101	ADDED CLEANLINESS CONTROL; FILTER ON SYSTEM SIDE OF SEAT; REDUNDANT CAP. CHANGED TEFLON STEM SEAL TO BUTYL RUBBER; GSE ATTACHING PORT FROM 5/16 TO 1/4 T.S.
TYPE OF TESTS	COMPONENT DYNAMIC TO 8101 LEVELS; REDUNDANT STEM SEAL OVER-TORQUE TESTS; R&D SYSTEM
PROBLEMS AND CORRECTIONS	VALVE MOUNTING PROBLEM; REQUIRED ADDITION OF MOUNTING LUGS; SYSTEM PFRT
QUALIFICATION	SYSTEM PFRT
PROBLEMS SINCE QUALIFICATION	NONE

MANUAL BLEED VALVE



8250-472050-5

TANK ISOLATION VALVE

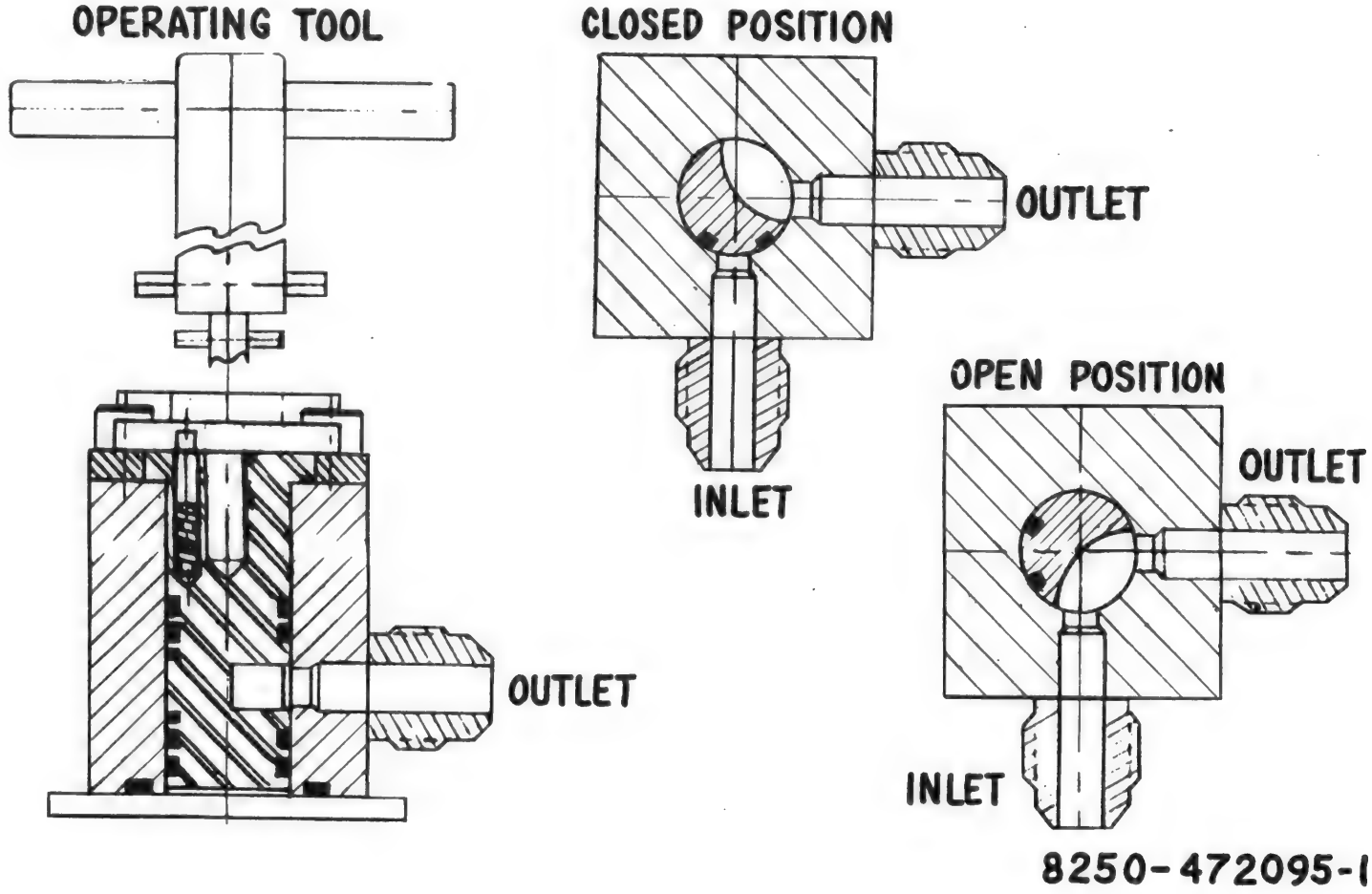
TYPE AND DESCRIPTION	MANUALLY OPERATED, PLUG TYPE
PRIMARY FUNCTION	TO ISOLATE THE PROPELLANT TANKS
PART NUMBER	8250-472095-1
TYPE OF TESTS	COMPONENT R&D TO 8101 LEVELS, CONDUCTED 1000 ENDURANCE CYCLES, SYSTEM R&D TEST
PROBLEMS AND CORRECTIONS	NONE
QUALIFICATION	COMPONENT PFRT ; DYNAMIC TESTS TO 8250 COMPONENT LEVELS, SYSTEM PFRT
PROBLEMS SINCE QUALIFICATION	NONE

8250 COMPONENT PFRT TESTS

FOR ISOLATION VALVE

1. PRESSURES
   - OPERATING : 205 PSIG
   - PROOF : 383 PSIG
2. TEST MEDIA : NITROGEN GAS PER MIL-P-2740 (USAF)
3. TEMPERATURE TESTS
   - a. HIGH TEMP: SOAK AT +160°F FOR 24 HRS, THEN F/T @ +100°F
   - b. LOW TEMP: SOAK AT -65°F FOR 24 HRS, THEN F/T @ 0°F
4. ENDURANCE TEST
   - CONDUCT 1000 OPERATING CYCLES
5. FUNCTIONAL TEST
   - a. LEAKAGE
   - b. FLOW VS PRESSURE DROP
   - c. ACTUATING TORQUE TEST
6. LIMIT LOAD TEST

TANK ISOLATION VALVE



8250 COMPONENT PFRT TESTS

7. ACTUATION WITH FULL ΔP FORWARD (262 PSIG @ INLET, OUTLET OPEN TO ATMOS)
   ACTUATION WITH FULL ΔP REVERSE (105 PSIG @ OUTLET, INLET OPEN TO ATMOS)
8. DYNAMIC TESTS
   a. SHOCK (6 MILLISECONDS DURATION AND A HALF SINE WAVE FORM, EACH SHOCK)
      40 G, 3 SHOCKS IN BOTH DIRECTIONS OF EACH PLANE FOR A TOTAL OF 18 SHOCKS
   b. ACCELERATION (10 MINUTE DURATION EACH DIRECTION)
      LONGITUDINAL AXIS: 12G AFT, 4 G FORWARD
      LATERAL AXES : 3G EACH DIRECTION
   c. SINUSOIDAL VIBRATION (45 MINUTES SWEEP FOR EACH AXIS)
      ALL 3 AXES : 5 TO 14 CPS @ ½" D.A.
      14 TO 40 CPS @ 5.0 g
      40 TO 400 CPS @ 7.5 g
      400 TO 3000 CPS @ 20.0 g.
   d. RANDOM VIBRATION (5 MINUTES ALONG EACH AXES)
      0.1 g^2/CPS @ 15 TO 2000 CPS UTILIZING A 2 SIGMA CLIPPER

8101 COMPONENT DEVELOPMENT TESTS

PRESSURES	HIGH PRESSURE UNITS	LOW PRESSURE UNITS
OPERATING	3600 PSIG	255 PSIG
PROOF	5400 PSIG	383 PSIG
BURST	7200 PSIG	510 PSIG

TEST FLUIDS

a. NITROGEN GAS. MIL-P-27401 (USAF) FOR GAS SYSTEM COMPONENTS

b. METHYLENE CHLORIDE MIL-D-6998 FOR MON " "

c. METHANOL (METHYL ALCOHOL) O-M-232 FOR UDMH " "

TEMPERATURE TESTS

a. HIGH TEMP : SOAK AT +160°F FOR 24 HRS – CONDUCT FUNCTIONAL TEST @ 100°F

b. LOW TEMP : SOAK AT -65°F FOR 24 HRS - CONDUCT FUNCTIONAL TEST @ 0°F

ENDURANCE TEST

CONDUCT OPERATIONAL CYCLE LIFE (1000 TO 10,000 CYCLES)

8101 COMPONENT DEVELOPMENT TESTS

ALTITUDE TESTS

CONDUCT FUNCTIONAL TESTS AT A SIMULATED ALTITUDE OF 262,000 FEET

RADIATION TESTS

EXPOSURE TO A TOTAL RADIATION DOSAGE OF 5×10^5 ROENTGENS

HUMIDITY, SAND & DUST, SALT SPRAY PER MIL-STD-810

ELECTRICAL TESTS (ON START VALVE & 3-WAY SOLENOID

a. DIELECTRIC STRENGTH

b. RESPONSE TESTS

8101 COMPONENT DEVELOPMENT TESTS

DYNAMIC TESTS

SHOCK —— 40G (3 SHOCKS, BOTH DIRECTIONS, EACH PLANE) 18 SHOCKS TOTAL
6 MILLISECONDS DURATION & AN APPROX. HALF SINE WAVE FORM, EACH SHOCK

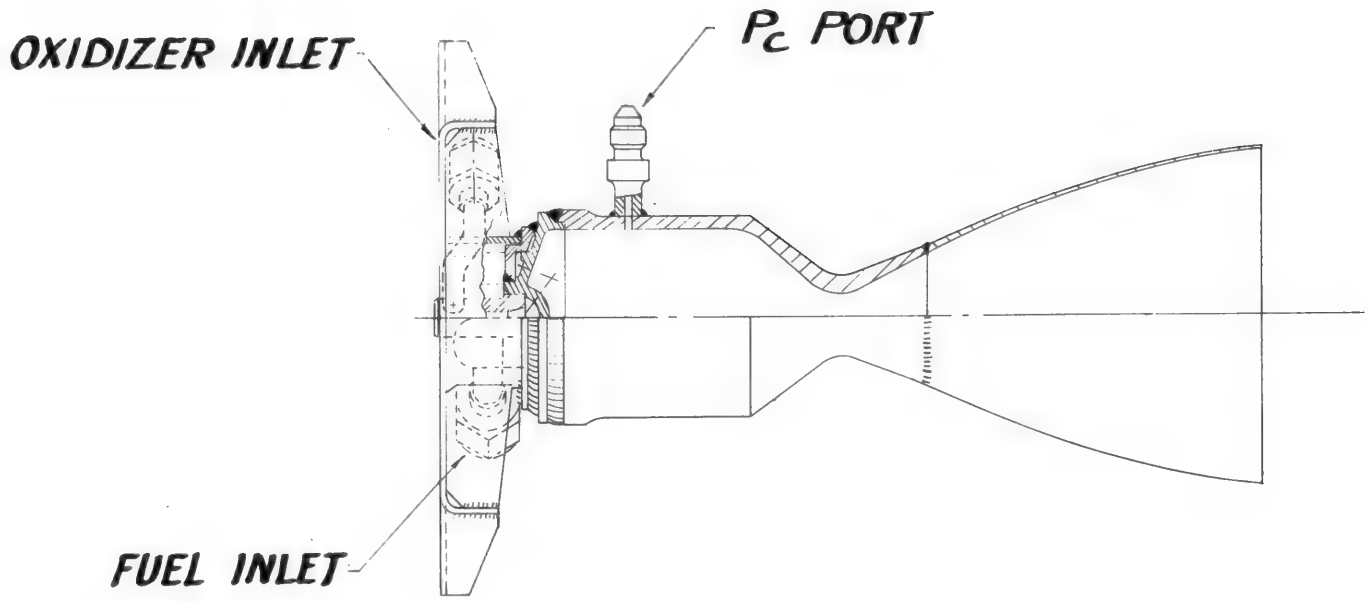
ACCELERATION — LONGITUDINAL AXIS, 12G AFT, 4G FORWARD — 10 MIN DURATION EACH
LATERAL AXIS, 3G EACH DIRECTION — 10 MIN DURATION EACH

SINUSOIDAL VIBRATION — (45 MINUTES ALONG EACH AXIS)

LONGITUDINAL AXIS	5 TO 15 CPS @ ½" D.A.
	15 TO 40 CPS @ 3G
	40 TO 400 CPS @ 7.5G
	400 TO 3000 CPS @ 20G
LATERAL AXES	5 TO 15 CPS @ ½" D.A
	15 TO 400 CPS @ 3 G
	400 TO 3000 CPS @ 7.5G

RANDOM VIBRATION (5 MINUTES ALONG EACH AXES
.05 g^2/CPS @ 15 TO 2000 CPS UTILIZING A 2 SIGMA CLIPPER

UNIT I THRUST CHAMBER



UNIT I

I. NAME OF COMPONENT	MODEL 8250 PART NO.	MODEL 8101 PART NO.
THRUST CHAMBER ASSY.	8250-470001	8101-470075

II. TYPE OF COMPONENT AND GENERAL DESCRIPTION

RADIATION COOLED $F = 16$ lb. $P_c = 80$ PSIA $\theta = .5 - 150$ SEC.

$\gamma = 1.10$ $A_e/A_t = 55.6$ $I_{SP\infty MIN.} = 241$ SEC.

PROPELLANT TEMPERATURE 0-100°F

III. COMPONENT HISTORY AND STATUS

A. EARLY 8101 TESTING

1. AMBIENT - DURABILITY

2. ELEVATED TEMPERATURE AND INVERSE TEMPERATURE

UNIT I

III B. REDESIGN

1. TOROIDAL MANIFOLD
2. MATERIAL CHANGES
3. FLAME DEFLECTORS
4. INTERNAL COATINGS
5. EXTERNAL COATINGS

C. Q/A PROGRAM

IV MODEL 8101

A. DEVELOPMENT LEVEL TESTS (INFORMAL PFRT)

1. DURABILITY
2. INVERSE TEMPERATURE
   a. HIGH P_c
   b. HIGH AND LOW τ { $\tau = 1.35 - 1.15$ / $\tau = 0.90 - 1.10$
   c. 100°F OXIDIZER & 40°F FUEL
   d. 40°F OXIDIZER & 100°F FUEL

UNIT I

III. MODEL 8101 CONT. (DEV. LEVEL TESTS - INFORMAL PFRT)

A. 3. ELEVATED ENVIRONMENT

a. HIGH P_c

b. 100°F PROPELLANTS

4. COLD TESTS (0°F PROPELLANTS & HARDWARE)

5. ULTRA-LOW COLD TESTS (0°F PROPS. -20°F HARDWARE)

6. SIMULATED P.V. FAIL TO CLOSE

7. SIMULATED BLADDER RUPTURE

8. MALFUNCTION TESTS (SEE M.A. REPT.)

9. ALTITUDE TESTING TO DETERMINE $C_{f\infty}$

UNIT I

IV MODEL 8101 CONT.

B. COMPONENT LEVEL FORMAL PFRT

1. CALIBRATION TESTS

a. 1-30 SEC. @ 100% RATED THRUST
b. 2-30 SEC. @ 90% " "
c. 2-30 SEC. @ 110% " "
d. 1-30 SEC. @ 100% " "
e. 2-10 SEC. @ 100% " "

2. SIMULATED BLADDER RUPTURE TESTS

a. OXIDIZER
b. FUEL

UNIT I

IV MODEL 8101 CONT.

C. SYSTEM LEVEL FORMAL PFRT SYSTEM NO. 1 (S/N 204)

1. CHECKOUT
2. ENVIRONMENTAL TESTS
   a. HIGH TEMPERATURE
   b. HIGH HUMIDITY
   c. LOW TEMPERATURE
3. SAFETY LIMITS
   a. START SHUTDOWN
      (1.) VARYING VOLTAGE
      (2.) REFEREE PROPELLANTS
4. MALFUNCTION TESTS
   a. START VALVE FAILURE
   b. PROPELLANT VALVE FAILURE TO CLOSE
   c. HIGH REGULATOR OUT PRESSURE (260 PSIA)
   d. LOW REGULATOR OUT PRESSURE (150 PSIA)
   e. SIMULATED FUEL EXHAUSTION
   f. SIMULATED OXIDIZER EXHAUSTION

UNIT I

IV MODEL 8101 CONT.

D. SYSTEM LEVEL FORMAL PFRT SYSTEM NO. 2 (S/N 105)

	T/C S/N (IA)	T/C S/N (IB)
1. FIXED THRUST No. I	8	13
2. FIXED THRUST NO. 2	3	13
3. INVERSE TEMPERATURE No. I	13	3
4. INVERSE TEMPERATURE No. 2	13	3
5. FIXED THRUST No. 3	13	3
6. FIXED THRUST No. 4	12	20

E. QUALIFICATION OF UNIT I

F. FLIGHT HISTORY

UNIT I

V. MODEL 8250

A. TYPE OF CHANGES (CHANGES FROM 8101)

1. CONTAMINATION CONTROL
2. FILTERS
3. P.V. GASKETS

B. PROBLEMS & CORRECTIONS

1. TRIM ORIFICE
2. FLOW RATES

C. COMPONENT TESTING

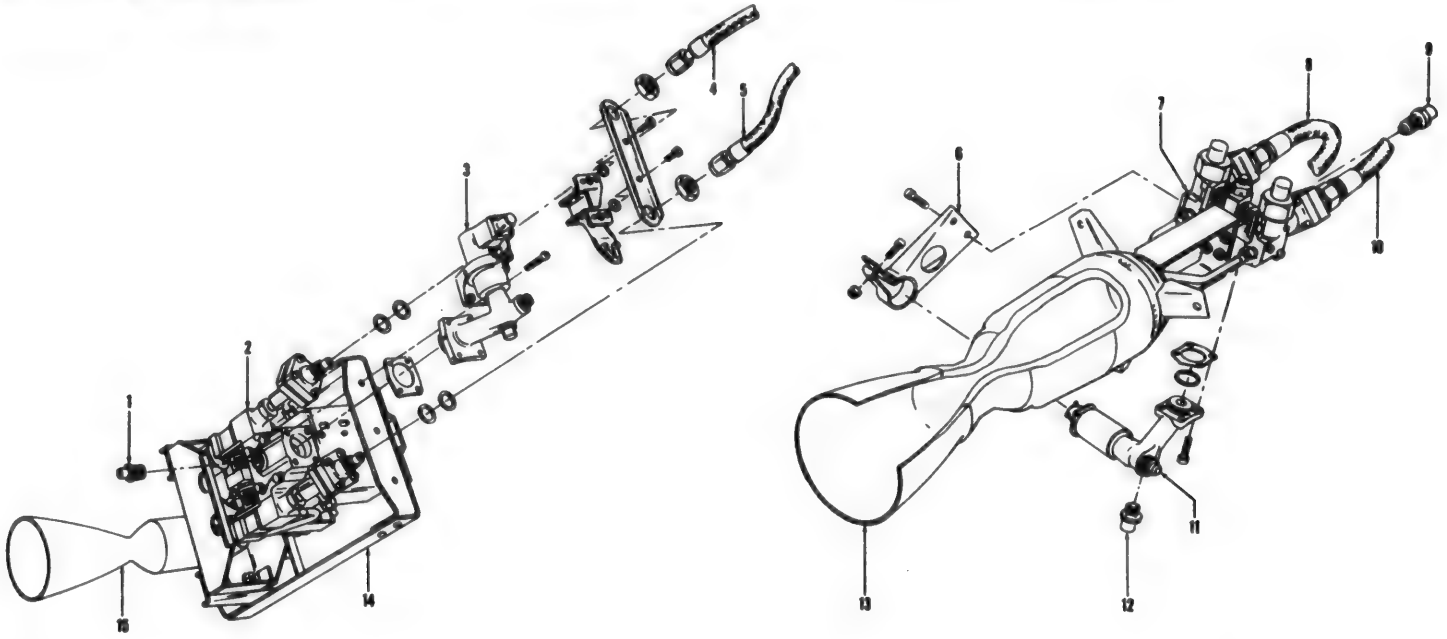
1. Q/A PROGRAM
2. COAST TESTS
3. LOW TEMPERATURE LIMITS
4 TEMPERATURE RANGE

D. COMPONENT LEVEL PFRT

E. SYSTEM LEVEL PFRT

Model 8250

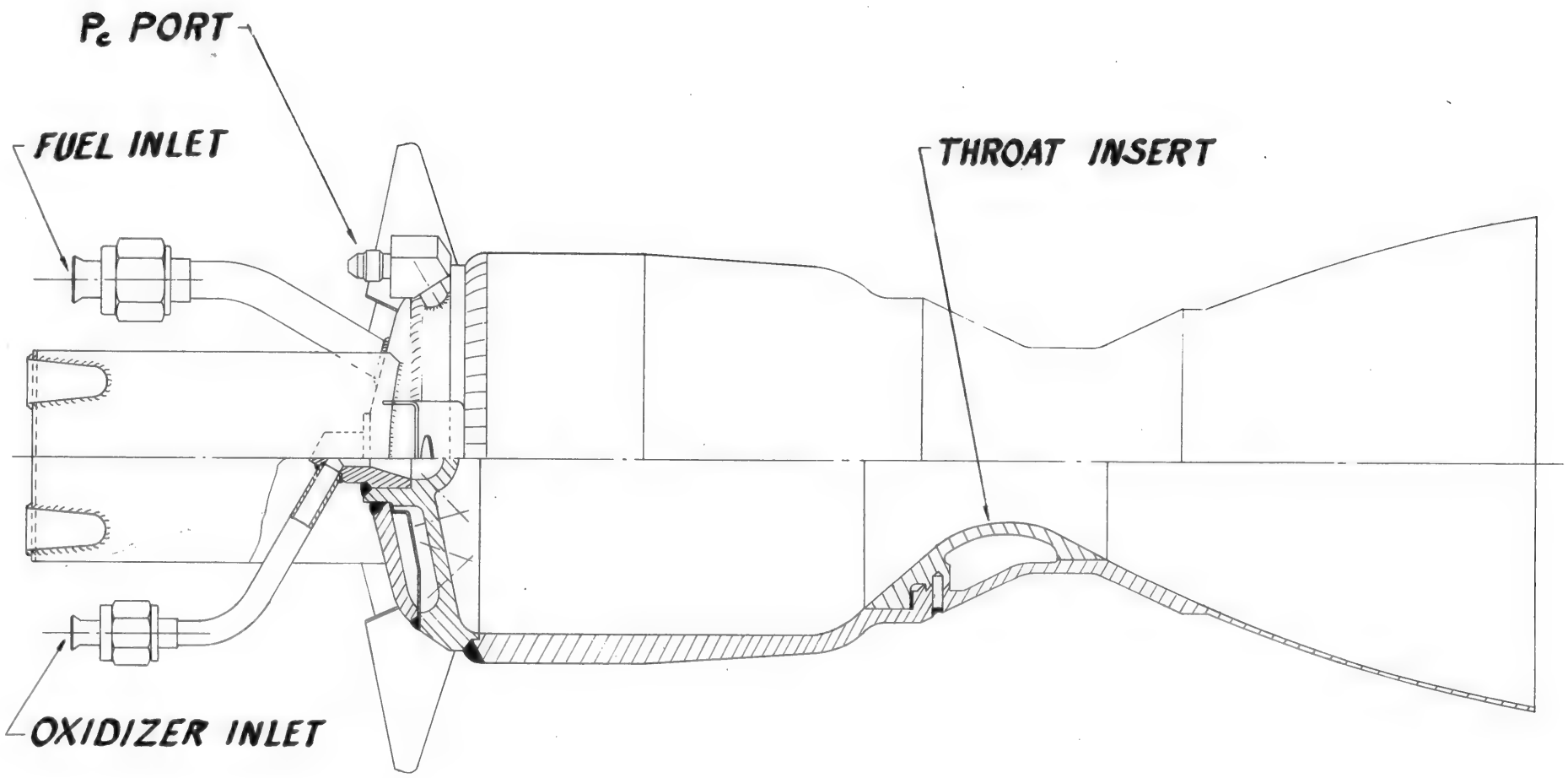
THRUST CHAMBER ASSEMBLIES (UNIT I & UNIT II)



1. Filter Assembly
2. Bi-propellant Valve
3. Solenoid Valve
4. Oxidizer Feed Line
5. Fuel Feed Line
6. Solenoid Support Bracket
7. Bi-propellant Valve
8. Fuel Feed Line
9. Filter Assembly
10. Oxidizer Feed Line
11. Solenoid Valve
12. Filter Assembly
13. Thrust Chamber, 200 lbs.
14. Support Bracket
15. Thrust Chamber, 16 lbs.

BELL AEROSYSTEMS

UNIT II THRUST CHAMBER



UNIT II

I. NAME OF COMPONENT	MODEL 8250 PART No.	MODEL 8101 PART No.
THRUST CHAMBER ASSEMBLY	8250-470010	8101-470010

II. TYPE OF COMPONENT AND GENERAL DESCRIPTION

HEAT SINK CHAMBER $F = 200$ lb. $P_c = 96$ PSIA $\theta = .5 - 50$ SEC'S.

$r = 1.15$ $A_e/A_t = 15.6$ $I_{sp_{\infty MIN}} = 249$ SEC'S.

PROPELLANT TEMPERATURES 0°-100°F

III. COMPONENT HISTORY AND STATUS

A. EARLY MODEL 8101 TESTING

1. AMBIENT DURABILITY
2. ELEVATED TEMPERATURE & INVERSE TEMPERATURE

UNIT II

III B. REDESIGN

1. CHAMBER WALL THICKNESS
2. NOZZLE WALL THICKNESS
3. TANTALUM NOZZLE GASKET
4. FLAME DEFLECTOR
5. BRACKET WELD

IV. MODEL 8101

A. DEVELOPMENT LEVEL TESTS (INFORMAL PFRT)

1. DURABILITY
2. INVERSE TEMPERATURES
   - a. HIGH P_c
   - b. HIGH & LOW r
   - c. 100°F OX AND 40°F FUEL
   - d. 40°F OX AND 100°F FUEL

UNIT II

IV MODEL 8101 CONT. (DEV. LEVEL TESTS)

A. 3. ELEVATED ENVIRONMENT

a. HIGH P_c

b. 100°F PROPELLANTS

4. COLD TESTS - (0°F PROPS. AND HARDWARE)

5. ULTRA-LOW COLD TESTS (0°F PROPS. & -100°F HARDWARE)

6. SIMULATED P.V. FAILURE TO CLOSE

7. SIMULATED BLADDER FAILURE

8. ALTITUDE TESTING TO DETERMINE $C_{f\infty}$

9. MALFUNCTION TESTS.

UNIT II

IV MODEL 8101 CONT.

B. COMPONENT LEVEL FORMAL PFRT

1. CALIBRATION TESTS

a. 1-30 SEC. @ 100% RATED THRUST

b. 2-30 SEC. @ 90% RATED THRUST

C. 2-30 SEC. @ 110% RATED THRUST

d. 2-10 SEC. @ 100% RATED THRUST

2. SIMULATED BLADDER RUPTURE TESTS

a. OXIDIZER

b. FUEL

C. SYSTEM LEVEL FORMAL PFRT SYSTEM NO. 1 (S/N 204)

1. CHECKOUT TESTS

UNIT II

IV MODEL 8101 CONT. (SYSTEMS LEVEL FORMAL PFRT)

C. 2. ELEVATED ENVIRONMENT

a. HIGH TEMPERATURE

(1.) B/O - S/N-2 - EVALUATION PROGRAM

(2.) P.V. POPPETS DEFORMED S/N-5

a. PENALTY TEST ON P.V. @ PFRT

b. HIGH HUMIDITY

C. COLD TEST

(1.) P.V. BELLOWS S/N-5 T.C.A. (J. PIRRONE) TRT (855 SEC'S.)

(2.) S/N-12 DID NOT FUNCTION. THROAT PLUG FELL OUT— CO_2 REACTED WITH UDMH & PLUGGED FUEL SIDE

3. SAFETY LIMITS

a. START SHUTDOWN

(1.) VARYING VOLTAGE

(2.) REFEREE PROPELLANTS

UNIT II

IV MODEL 8101 CONT. (SYSTEMS LEVEL FORMAL PFRT)

C. 2. C. 4. MALFUNCTION TESTS

a. START VALVE FAILURE

b. PROP VALVE FAIL TO CLOSE

c. HIGH REGULATOR OUT PRESSURE (260 PSIA)

d. LOW REGULATOR OUT PRESSURE (150 PSIA)

e. SIMULATED FUEL EXHAUSTION

f. SIMULATED OXIDIZER EXHAUSTION

D. SYSTEM LEVEL FORMAL PFRT SYSTEM NO. 2 (S/N 105)

1. FIXED THRUST No. 1

2. FIXED THRUST No. 2

3. INVERSE TEMPERATURE No. 1

4. INVERSE TEMPERATURE No. 2

UNIT II

IV. MODEL 8101 CONT. (SYSTEMS LEVEL FORMAL PFRT SYSTEM NO. 2)

D. 5. FIXED THRUST No. 3

6. FIXED THRUST No. 4

a. T.C. S/N-8 TRT - 556 SEC'S.

b. T.C. S/N-10 TRT - 510 SEC'S.

E. QUALIFICATION OF UNIT II

F. FLIGHT HISTORY.

V. MODEL 8250

A. TYPE OF CHANGES (CHANGES FROM 8101)

1. CONTAMINATION CONTROL

2. FILTERS

3. P.V. GASKET

UNIT II

V MODEL 8250 CONT.

B. PROBLEMS AND CORRECTIONS

1. TRIM ORIFICE
2. FLOW RATES
3. WRAP AROUND PADS

C. COMPONENT TESTING

1. HIGH FEED PRESSURE DECAY
2. COAST TESTS - PREDICTED FROM 8250 ANALYSIS
3. LOW TEMPERATURE LIMITS FROM 8101 UNIT I TESTS & 8250 ANALYS.
4. BURNOUT INVESTIGATION

D. COMPONENT LEVEL PFRT

E. SYSTEM LEVEL PFRT

MODEL 8250 S.P.S. TANKS

NAME - TANKS - FUEL AND OXIDIZER

THE MODEL 8250 PROPELLANT TANKS ARE POSITIVE EXPULSION DEVICES UTILIZING A 347 SS WELDED BELLOWS INSIDE OF AN A286 CYLINDRICAL SHELL. BOTH OX & FUEL TANKS ARE SIMILAR EXCEPT FOR LENGTH & NUMBER OF CONVOLUTIONS.

FUNCTION -

THE FUNCTION OF THE BELLOWS TANKS IS TO STORE THE PROP-ELLANTS & ON DEMAND, TO PROVIDE THE SPS THRUST UNITS WITH A CONTINUOUS FLOW OF LIQUID PROPELLANTS.

COMPONENT HISTORY -

THE BELLOWS CONCEPT AS A POSITIVE EXPULSION DEVICE FOLLOWED THE 8101 BLADDER TANKS. THE NEED FOR A MORE RELIABLE DEVICE INDICATED THE USE OF A BELLOWS TANK. A DEVELOPMENT PROGRAM WAS INSTITUTED & PERFORMED.

STATUS -

THE TANKS ARE BEING PROVIDED IN THE FOLLOWING CONFIGURATIONS -

8250-471301-1 FUEL TANK

8250-471302-1 OXIDIZER TANK

TYPE OF TESTING -

THE MODEL 8250 TESTING WAS CONDUCTED WITH BELLOWS OF $7\frac{1}{8}$ INCH DIAMETER & 10 INCH DIAMETER. THESE TESTS DEMONSTRATED THE FOLLOWING -

A - FLOW & TRAVEL CHARACTERISTICS

B - VOLUME, SPRING RATE & HYSTERESIS

C - DYNAMICS CHARACTERISTICS

D - COMPATIBILITY WITH PROPELLANTS

E - CONTAMINATION CONTROL CAPABILITY

THESE TESTS WERE CONDUCTED WITH VARIOUS LENGTHS OF BELLOWS. SOME OF THE TESTED BELLOWS HAD 10, 20, 95, 135 & 149 CONVOLUTIONS.

PROBLEMS & CORRECTIVE ACTIONS (C.A.)

1 SHELL PROBLEM - WELD CRACKING ENCOUNTERED DURING FABRICATION.

C.A. - A. RIGID REQUIREMENTS IMPOSED ON A286 MAT'L CHEMISTRY

B. PLATE OR FORGED BILLET REPLACED BY CLOSED DIE FORGING

C. FIXTURING & PROCESS IMPROVEMENTS —

(CHILL BARS, BACK UP RINGS, TEMPERATURE CONTROL)

2 BELLOWS PROBLEMS -

A - BELLOWS FAILURE IN VIBRATION DURING ACCORDIAN MODE

C.A. - ADDITION OF BELLOWS BAFFLES TO ATTENUATE ACCORDIAN MODE

2 BAFFLES IN OX BELLOWS & 3 BAFFLES IN FUEL BELLOWS

B - BELLOWS FAILURE IN RANDOM VIBRATION

C.A. - RELIEF GRANTED BY LMSC

C - BELLOWS COCKING DURING FILL CYCLE

C.A. - REDUCE DEVIATIONS IN BELLOWS TRAVEL BY NORMALIZING BELLOWS

- CONTROL SHELL SIZE & OVALITY BY TIGHTER FABRICATION CONTROL
- TEFLON COATING ON OUTER EDGE OF MOVEABLE HEAD (A TEFLON COATED TEST BELLOWS WAS CYCLED OVER 80 TIMES IN ATTITUDES VARYING FROM VERTICAL TO HORIZONTAL. THE INCREMENTS OF DEFLECTION WERE FROM 1° TO 9°)

QUALIFICATION -

QUALIFICATION WAS PERFORMED DURING DEVELOPMENT TESTING AND DURING THE SYSTEM PFRT TESTING

A- A TANK WITH A TEFLON COATED HEAD WAS SUBJECTED TO RANDOM LATERAL VIBRATION. THE COATING WAS SLIGHTLY ABRADED BUT ENOUGH TEFLON REMAINED TO INSURE SMOOTH TRAVEL

B- 3 PROTOTYPE & 6 TEST TANKS WERE TESTED TO HIGH LEVEL DYNAMICS REQUIREMENT. 3 MORE PROTOTYPE TANKS WERE TESTED SATISFACTORILY TO THE REDUCED DYNAMICS LEVEL. IN ADDITION, A SYSTEM WITH TANKS WAS SUBJECTED TO FORMAL PFRT SYSTEM DYNAMIC LEVELS SATISFACTORILY. THESE PFRT TANKS WERE THEN EXPULSION CYCLED TO 201 (OX) & 207 (FUEL). THE SHELLS WERE THEN PRESSURE CYCLED, PROOF TESTED & BURST. (OX 596#, FUEL 606#)

PROBLEMS TO QUALIFIED HARDWARE & CORRECTIVE ACTION (C.A.)

A- CREVICE CORROSION CAUSED BY CHEMICAL ATTACK ON EDGE OF WELD

C.A. (PROPOSED) 1- INHIBIT THE NITRIC ACID PASSIVATING SOLUTIONS.

2- REVISE PROCESSING TO ELIMINATE ALL H.F. SOLUTIONS.

3- RIGID HEAT TREAT CONTROL TO REDUCE DISCOLORATION & SCALING.

4- MECHANICAL CLEANING OF HEAT TREATED PARTS & WITH INHIBITED PASSIVATING SOLUTIONS ONLY.

GAS BOTTLE - (8101-471001-3 & 8250-471030-1)

THE GAS BOTTLE IS A TITANIUM SPHERE USED TO STORE NITROGEN GAS AT HIGH PRESSURE FOR USE AS REQUIRED IN THE SYSTEM TO EFFECT A TRANSFER OF PROPELLANTS TO THE THRUST UNITS.

THE GAS BOTTLE WAS QUALIFIED ON THE 8101 PROGRAM. SEVERAL BOTTLES WERE PRESSURE CYCLED, PROOF TESTED TO 6000 PSIG & BURST TESTED. (BURST PRESSURES WERE APPROXIMATELY 9200 TO 9555 PSIG WHICH IS WELL IN EXCESS OF DESIGN BURST-8000 PSIG)

CHANGES TO THE GAS BOTTLE SINCE QUALIFICATION —

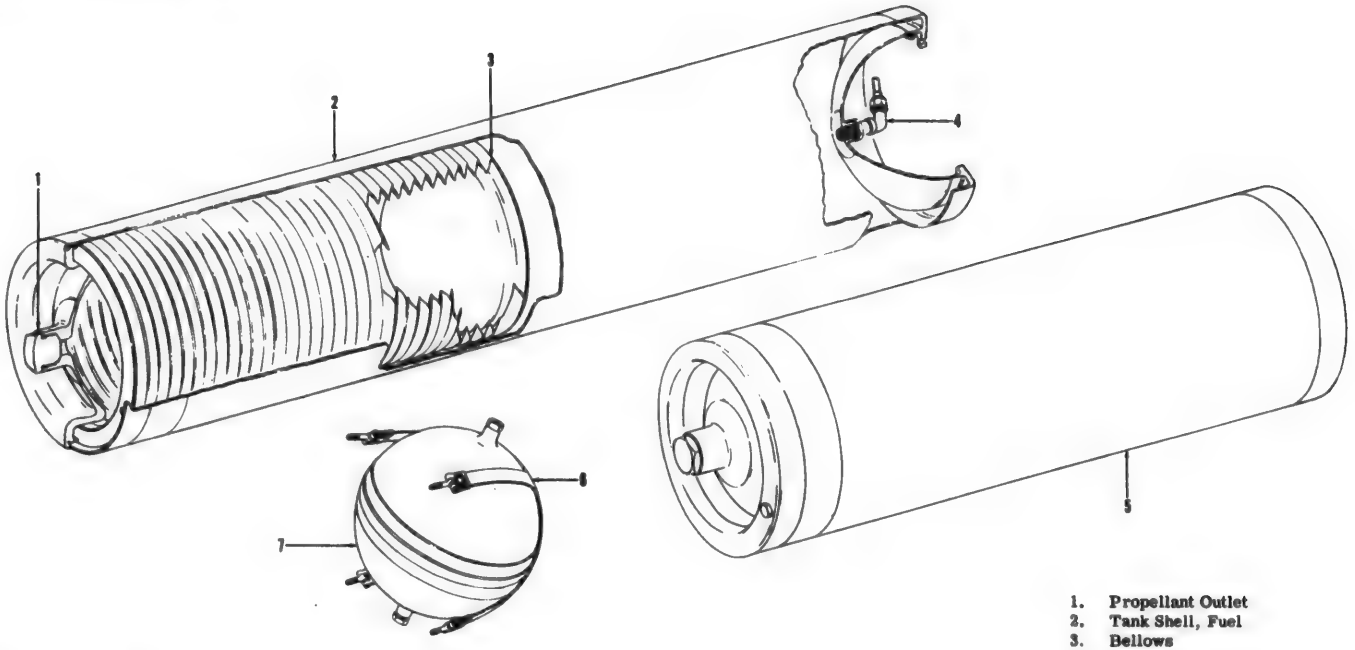
ADDED A CONTAMINATION CONTROL REQUIREMENT & CHANGED THE PART NUMBER TO REFLECT MODEL 8250.

MODEL 8250 FLIGHT HISTORY - NONE

PROPELLANT TANK DYNAMIC REQUIREMENTS

SHOCK	
LONGITUDINAL AXIS	35 g
LATERAL AXES	15 g
ACCELERATION	
LONGITUDINAL AXIS	12 g FORWARD 1 g AFT
LATERAL AXES	± 3 g
SINUSOIDAL VIBRATION	
LONGITUDINAL AND LATERAL AXES	0.5 TO 5 CPS AT ¼ INCH SINGLE AMPLITUDE
	5 TO 11 CPS AT ⅛ INCH SINGLE AMPLITUDE
	11 TO 90 CPS AT 1.5 g
	90 TO 600 CPS AT 2.0 g

Model 8250 TANK ASSEMBLIES



1. Propellant Outlet
2. Tank Shell, Fuel
3. Bellows
4. Gas Inlet
5. Oxidizer Tank
6. Strap Assembly
7. Nitrogen Tank

BELL

MODEL 8101 SYSTEM

1. COMPONENTS MOUNTED IN VARIOUS AREAS OF VEHICLE
2. COMPLEX CONFIGURATION
3. R & D TESTING
4. PFRT TESTING

MODEL 8250 SYSTEM

1. MODULAR CONCEPT
2. SIMPLIFIED CONFIGURATION
3. CONTAMINATION CONTROL

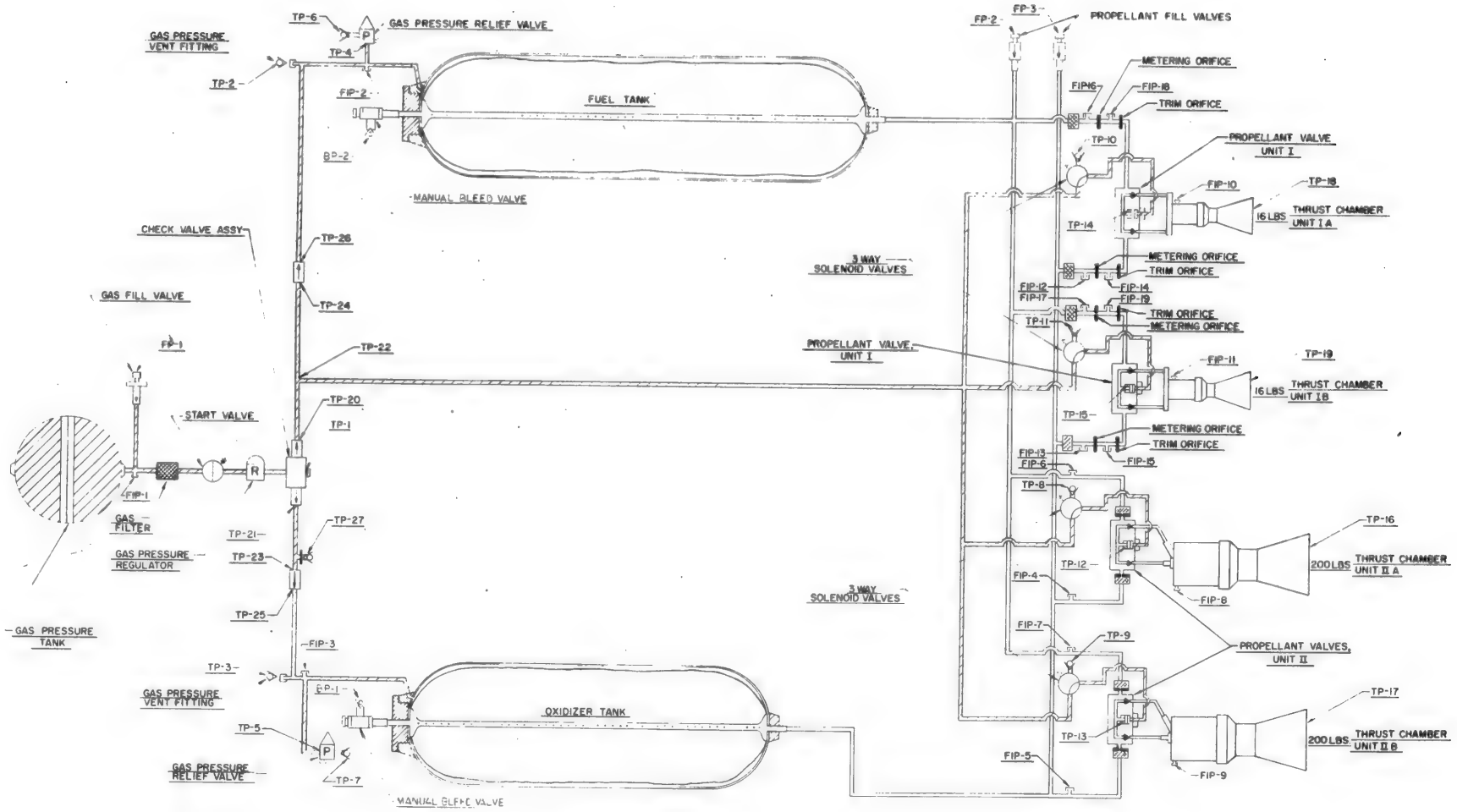
MODEL 8101 SYSTEM

1. COMPONENTS MOUNTED IN VARIOUS AREAS OF VEHICLE
2. COMPLEX CONFIGURATION
3. R & D TESTING
4. PFRT TESTING

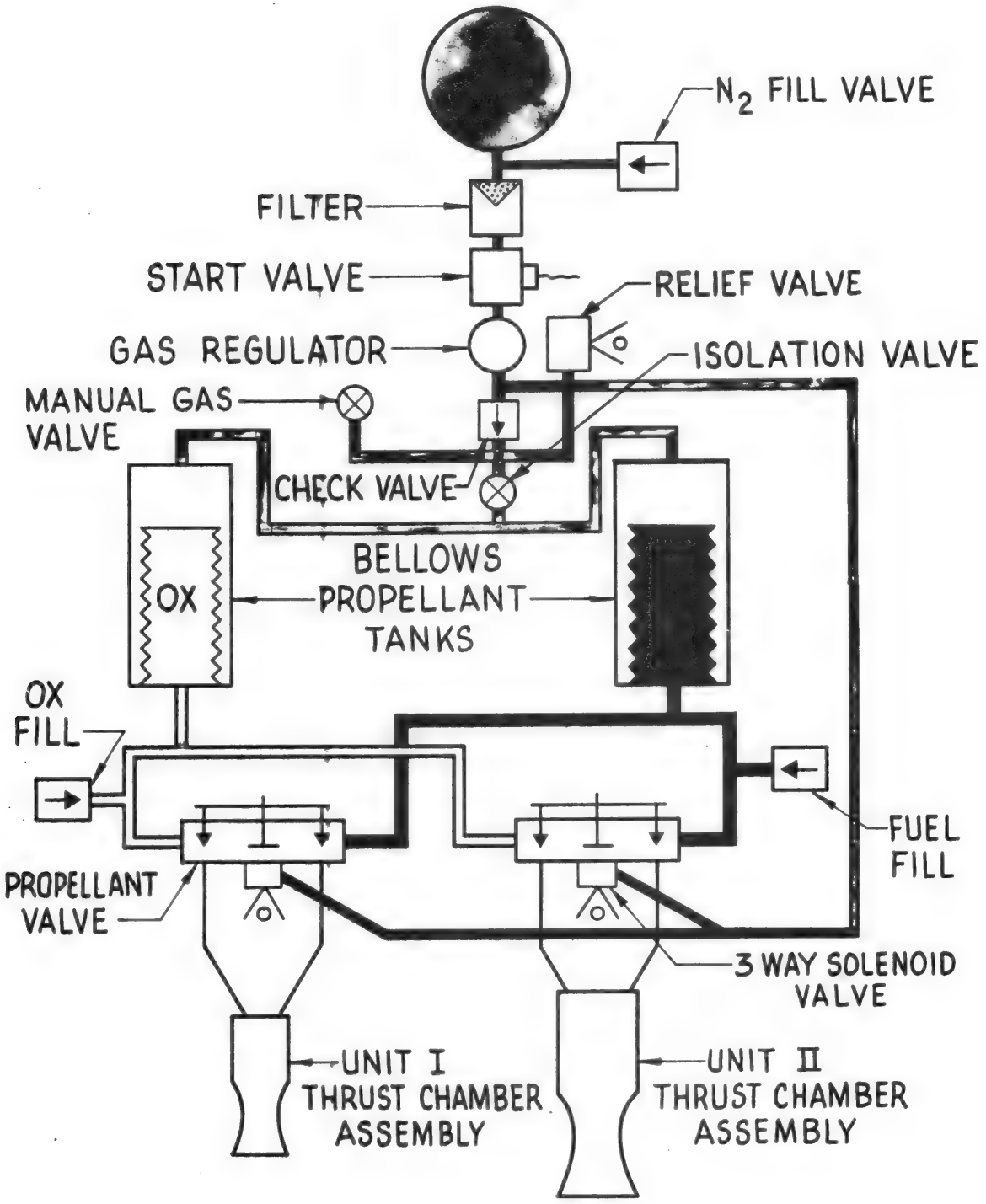
MODEL 8250 SYSTEM

1. MODULAR CONCEPT
2. SIMPLIFIED CONFIGURATION
3. CONTAMINATION CONTROL

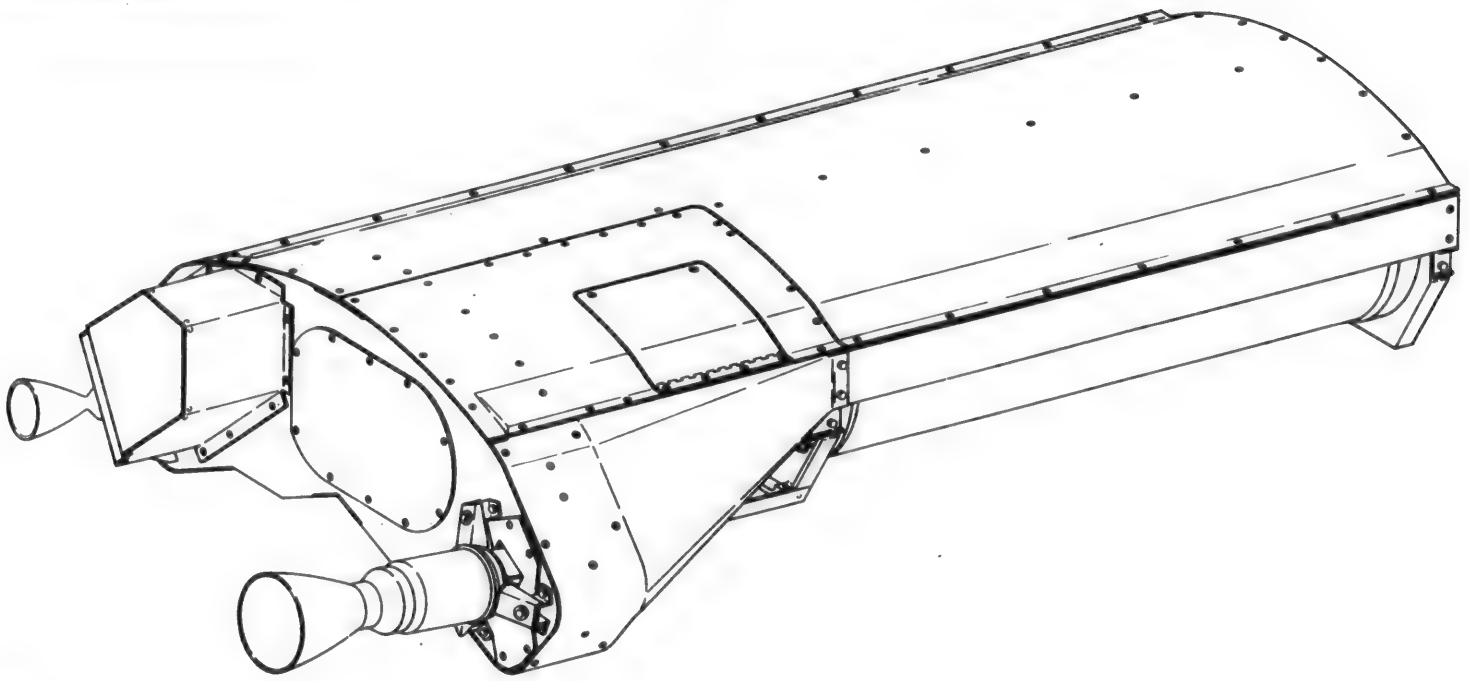
MODEL 8101 SYSTEM



MODEL 8250
SYSTEM WITH BELLOWS TANKS



Model 8250 MODULE – SECONDARY PROPULSION SYSTEM

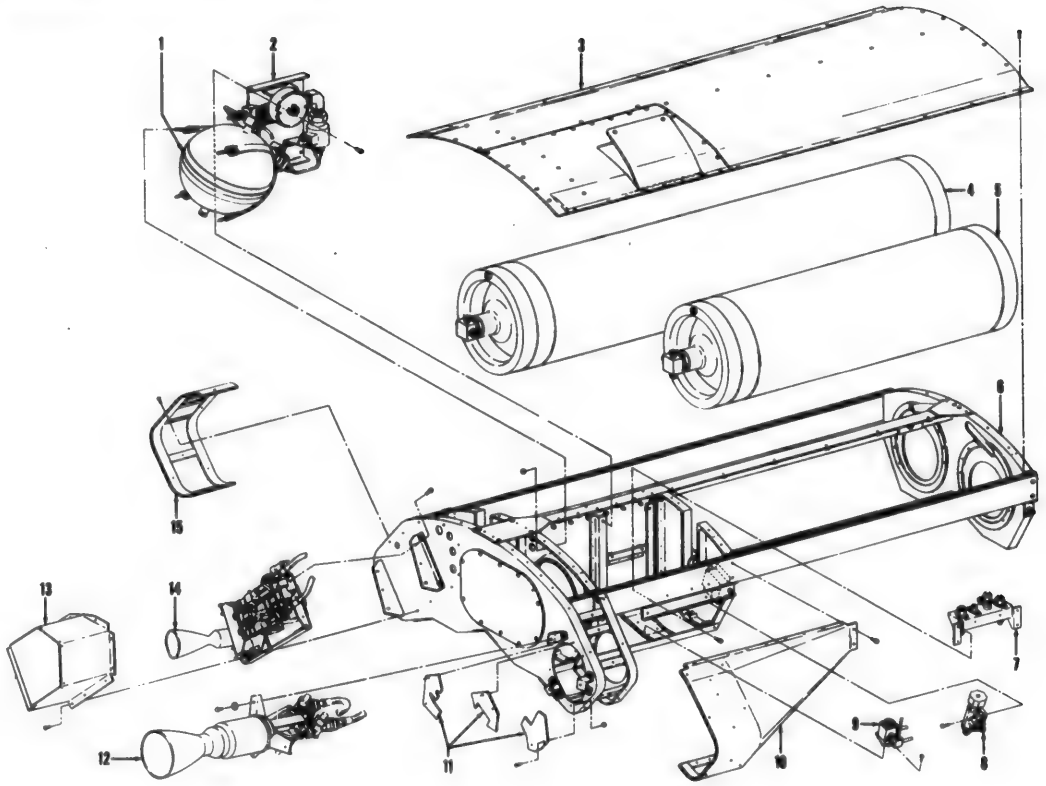


BELL

Model 8250

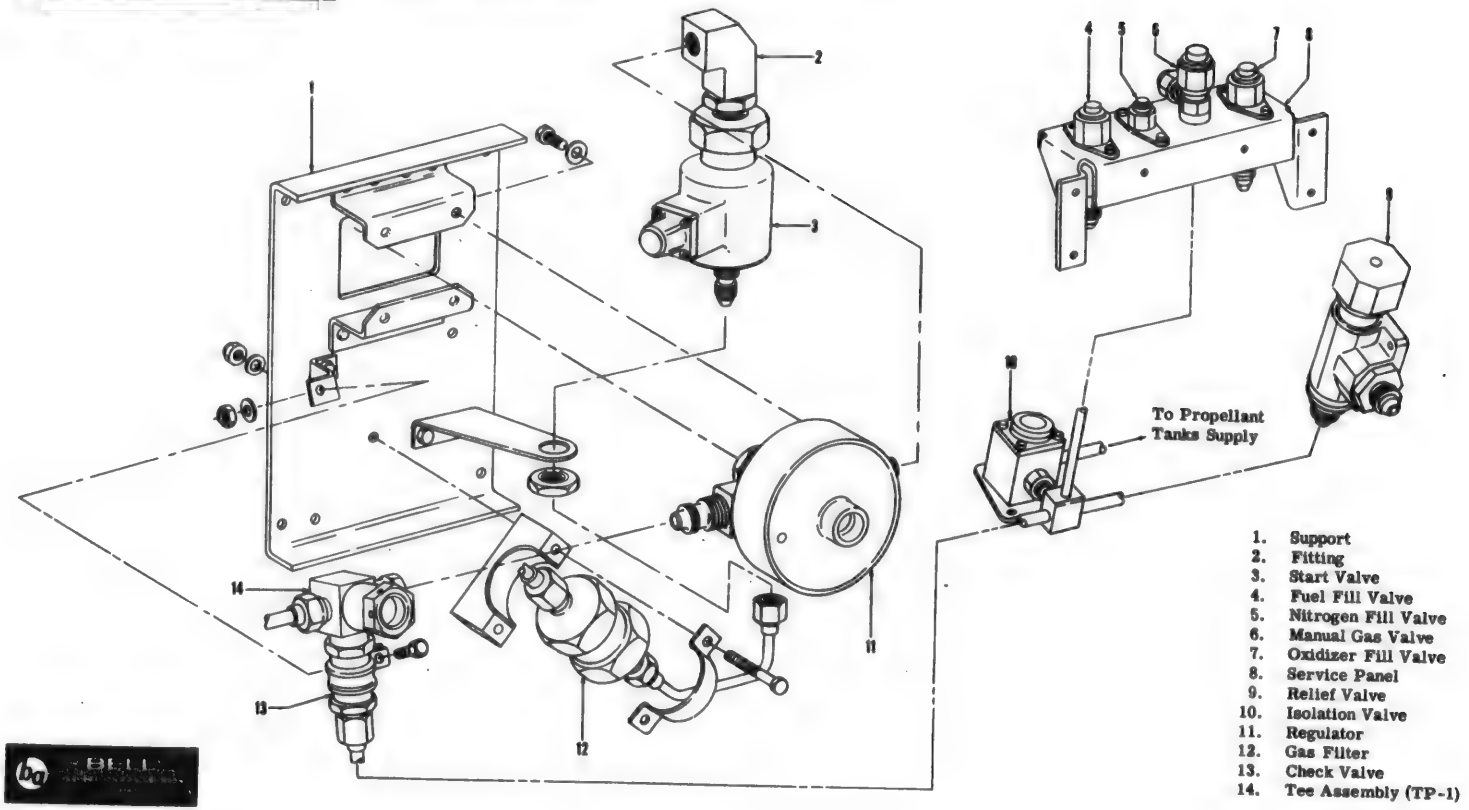
MODULE COMPONENTS

1. Nitrogen Tank
2. Pressurization Assembly
3. Cover, Tanks
4. Fuel Tank
5. Oxidizer Tank
6. Frame Assembly
7. Service Panel
8. Relief Valve
9. Isolation Valve
10. Cover, Unit II Support
11. Unit II Closures
12. Unit II Thrust Chamber Assembly
13. Cover, Unit I Support
14. Unit I Thrust Chamber Assembly
15. Cover, Unit I Support



Model 8250

PRESSURIZATION COMPONENTS



1. Support
2. Fitting
3. Start Valve
4. Fuel Fill Valve
5. Nitrogen Fill Valve
6. Manual Gas Valve
7. Oxidizer Fill Valve
8. Service Panel
9. Relief Valve
10. Isolation Valve
11. Regulator
12. Gas Filter
13. Check Valve
14. Tee Assembly (TP-1)

R AND D DYNAMIC TEST ON SYSTEM T-1

DESCRIPTION OF SYSTEM

DYNAMIC LEVELS

PROBLEMS

1. CRACK NOTED IN 8250-460017 BULKHEAD; REDESIGN OF CORNER AND ADD GUSSET. 8250-46016 BULKHEAD WAS CHANGED IN LIKE MANNER
2. CRACK NOTED AT THE UNIT II THRUST CHAMBER PROPELLANT VALVE MOUNTING PADS: REDESIGN OF DOUBLER PADS
3. RUBBING NOTED BETWEEN UNIT I OX FEED FLEX LINE AND UNIT I COVER: LINE POSITION WAS ADJUSTED
4. LOSS OF APPROX 45 POUNDS OF SIMULATED PROPELLANT DUE TO TEST LINES AND VALVES; ANALYSIS INDICATED NO PROBLEM WOULD BE ENCOUNTERED AT MAX WEIGHT DURING PFRT

R & D FIRE TESTING ON SYSTEM S/N T-2

SEVEN TESTS CONDUCTED ON SYSTEM T-2 INCLUDED, AMBIENT, HIGH TEMPERATURE AND LOW TEMPERATURE TESTS

PROBLEMS

1. GAS FILL VALVE INSTALLED BACKWARDS; NOTCH ADDED TO FLANGE ON VALVE AND PIN ADDED TO SERVICE PANEL
2. PORT ON UNIT II SOLENOID VALVE COULD NOT BE REACHED; A HOLE WAS ADDED TO THE STRUCTURE
3. FUEL TANK S/N 4 BELLOWS HEAD COCKED; TANK HEAD FREED AND TANK REINSTALLED
4. GAS REGULATOR OUT OF SPEC. AFTER 3RD TEST; REDESIGN AND REGULATOR TEST PROGRAM
5. GAS FILL VALVE LEAKING; SHRED OF TEFLON ON SEAT
6. FUEL TANK S/N 4 DAMAGED DUE TO TESTING ERROR; PROCEDURE CHANGES
7. UNIT II TCA FAILURE ON HOT TEST; "BURN OUT" PROGRAM
8. PROPELLANT LOADING DISCREPANCY; CHANGES TO PROCEDURES AND CHECKS ON CALIBRATION METHODS

MODEL 8250 SYSTEM PFRT

SINUSOIDAL VIBRATION AND ACCELERATION TESTS

SINUSOIDAL VIBRATION *

LONGITUDINAL AXIS	5 TO 11 CPS AT 0.125 INCH SINGLE AMPLITUDE
	11 TO 90 CPS AT 1.5g
	90 TO 1000 CPS AT 2.0g
LATERAL AXES	5 TO 11 CPS AT 0.125 INCH SINGLE AMPLITUDE
	11 TO 1000 CPS AT 1.5g

THE VIBRATION WAS APPLIED AT A CONSTANT OCTAVE SWEEP FROM THE LOWEST TO THE HIGHEST FREQUENCY IN 24 MIN.

ACCELERATION *

LONGITUDINAL AXIS	12g FORWARD
	1g AFT
LATERAL AXES	±3g

THE ACCELERATION WAS APPLIED FOR 10 MINUTES EACH DIRECTION PARALLEL TO THE INDICATED SATELLITE AXIS

*SYSTEM FULLY LOADED WITH TEST FLUIDS AND PRESSURIZED TO OPERATING PRESSURES EXCEPT THE GAS PRESS. TANK WAS PRESSURIZED TO 2230 PSIG WITH ARGON

MODEL 8250 PFRT

QUALIFICATION

PRE-PFRT TESTING

SYSTEM ACCEPTANCE TEST WITH TEST TANKS
PROPELLANT TANK SET S/N 9 – CYCLED PRIOR TO INSTALLATION

DYNAMIC TESTS

STATIC LEAKAGE AND FUNCTIONAL TEST
HELI-COIL INSTALLATION IMPROPER

ACCELERATION TESTING
POST ACCEL. PRESS. CHECKS – LEAK AT GAS END OF OX TANK

SINUSOIDAL VIBRATION
PRE-TEST – POSITION STRIPE ON RELIEF VALVE ADJUSTMENT CAP MISSING

X AXIS VIBRATION
GAS PRESS. TANK MOUNTING SCREWS TORQUED TO 25 IN. LB

MODEL 8250 PFRT

Z AXIS VIBRATION
RIPPLES IN OXIDIZER TANK

Y AXIS VIBRATION

POST DYNAMIC TEST PRESSURE CHECKS

PREPARE FOR SHIPMENT TO BTC FUEL VALVE LEAKING

FIRE TEST

STATIC LEAKAGE AND FUNCTIONAL CHECK

PFRT FIRE TEST INCLUDED FIXED THRUST TESTS, HUMIDITY, AND HIGH & LOW TEMPERATURE TESTS

PROBLEMS

FIXED THRUST TESTS
UNIT I PROPELLANT VALVE FAILURE DUE TO SALTS ON OXIDIZER SIDE; GOLD GASKETS INSTALLED

HIGH TEMPERATURE TEST
UNIT II THRUST CHAMBER BURN-OUT

MODEL 8250 PFRT

HUMIDITY TESTS

- CORROSION IN STAGNANT AREAS & WHERE ANODIZE COATING WAS BROKEN
- RUST ON SOLENOID VALVE
- HEAT CONDUCTION STRAP CORROSION

COLD TEST

- LEAKS AT TEFLON 'O' RING SEALS ; DESIGN CHANGE
- LEAKS AT TUBING CONNECTION ; TORQUE CHECKS INITIATED

FINAL STATIC LEAKAGE AND FUNCTIONAL CHECK

MODEL 8250 LAUNCH HOLD PROGRAM

TEST CONDUCTED TO DEMONSTRATE WET AND DRY HOLD CAPABILITY

TEST CONDUCTED ON DELIVERABLE SYSTEM S/N 4

TEST

- NORMAL ACCEPTANCE TEST
- 20 DAY DRY STORAGE WITH TEMPERATURE CYCLE
- INSTRUMENTATION INSTALLATION
- 20 DAY WET STORAGE WITH PROPELLANTS LOADED
- RE-ACCEPTANCE TEST WITH 5 DAY COAST
- DATA

RELIABILITY PROGRAM – MODELS 8247 & 8250

PROGRAM INITIATED — OCTOBER 15, 1963

COMPLETION DATE — APRIL 30, 1966

PROGRAM TASKS

PROGRAM PLAN

INDOCTRINATION
- MOTIVATORS
- FILMS

DESIGN SUPPORT
- DESIGN REVIEW
- FAILURE MODES & EFFECTS ANALYSIS
- STATUS MEETINGS
- ANALYSIS SERVICE

DOCUMENTATION REVIEW
- PROCESS & MATERIAL SPEC
- E.O. CHANGES

FAILURE ANALYSIS
- BAC PROCEDURE

RELIABILITY PROGRAM — MODELS 8247 & 8250

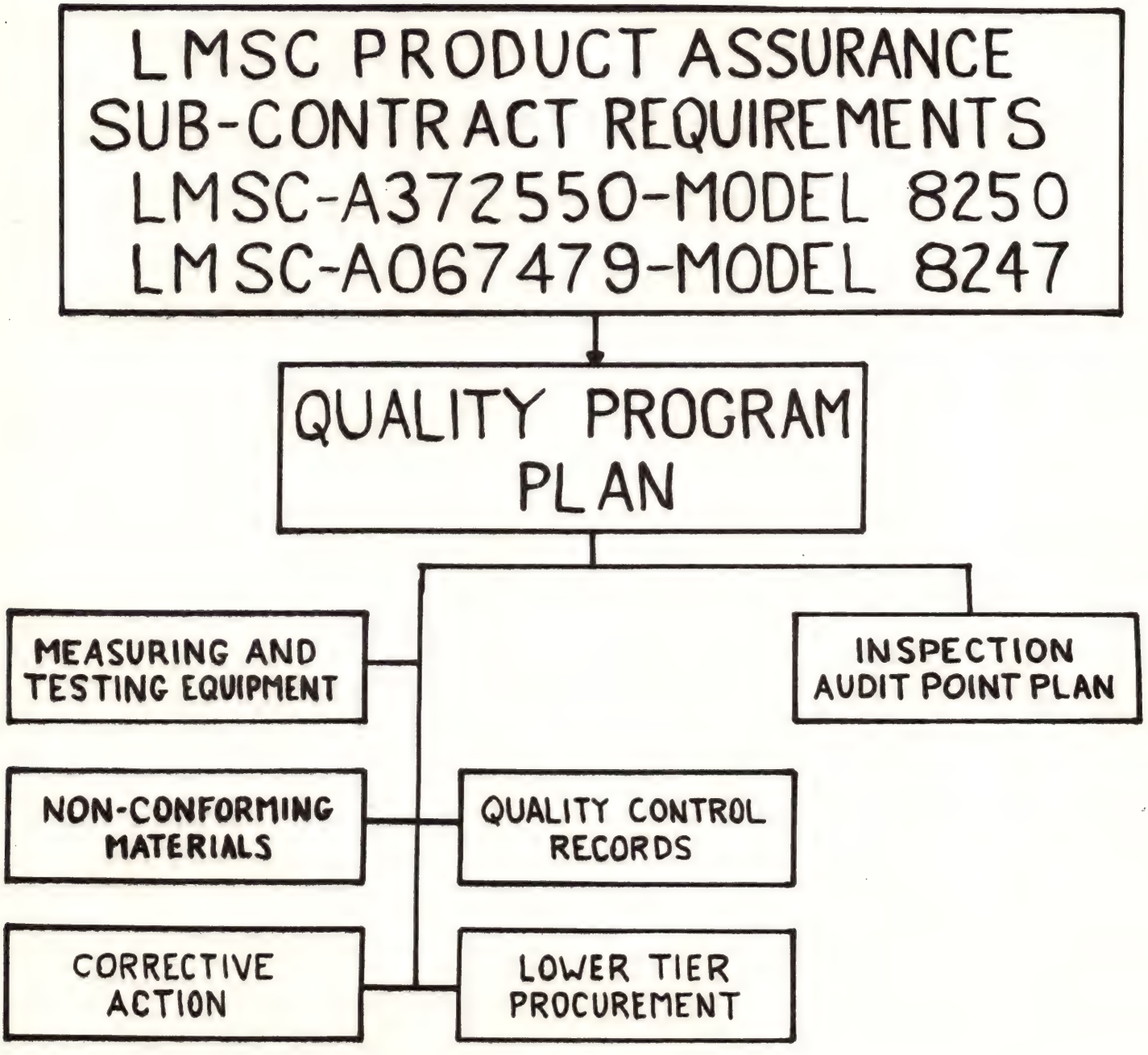
SUPPLIER REVIEW
- FUNCTIONAL TEST
- SPECIFICATIONS & DRAWINGS
- SUB-CONTRACTOR PERFORMANCE

MANUFACTURING ASSURANCE
- AREA REVIEW
- PROCESSES

DATA REVIEW
- COLLECT & RECORD DATA
- TEST DATA ANALYSIS

PROGRAM REPORTS
- RELIABILITY MONTHLY
- QUARTERLY ESTIMATE

QUALITY PROGRAM REQUIREMENTS MIL-Q-9858



BELL AEROSYSTEMS COMPANY

QUALITY DEPARTMENT

BAC MODEL 8247 - AF MODEL XLR 81-BA-13
INSPECTION AUDIT POINT PLAN

DATE APPROVAL 5-18-64 J. T. Bailey

DELIVERY AND SHIPPING
INSPECTION PROCEDURE
1) PACKING SHEET
2) MIL-E-6124A CONTAINER PRESSURIZATION

ENGINE ASSEMBLY 8247-475200
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) INSPECTION CHECKLIST
A - 64-630 COMPONENT INSTALLATION
B - 60-70 PROTECTIVE COAT CONDITION
C - 62-210-1 RESIDUE INSPECTION
3) RADIOGRAPHIC INSPECTION
4) BUSHING MEASUREMENTS -ENG MOUNT & T.C.
5) T.P. INLET LOCATIONS
6) ASSEMBLY HISTORY SHEETS
7) COMPONENT HISTORY CARDS
8) QUALITY CERTIFICATION SHEET
9) CONFIGURATION VERIFICATION
10) DD829 - HISTORICAL RECORD FOR AERONAUTICAL EQUIPMENT

TEST PROCEDURE
1) 8247-928201 A/T PROCEDURE
2) INSPECTION CHECKLISTS
A - 64-634 ENGINE A/T

MISCELLANEOUS BRACKETS & CLIPS
INSPECTION PROCEDURE
1) B/P NOTES

DUCT ASSY - EXHAUST 8096-475105
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) RADIOGRAPHIC INSPECT
4) ICL 64-130
TEST PROCEDURE
1) QDTP DATA SHEET
2) B/P NOTES

CABLE ASSY 8247-472291
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) B/P NOTES

ELECTRONIC GATE (OSP) 8247-472283
INSPECTION PROCEDURE
1) CERTIFICATION SHEET
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) 8247B472283 BOOK FORM DRAWING

THRUST CHAMBER ASSY 8247-470001
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) ASSEMBLY HISTORY SHEET 63-31
3) COMPONENT HISTORY CARD
4) INSPECTION CHECKLISTS
A - 63-586 COMPONENT INSTALLATION
B - 60-70 PROTECTIVE COAT CONDITION
5) RADIOGRAPHIC INSPECTION
TEST PROCEDURE
1) 8096-928003 A/T PROCEDURE
2) I.C.L. 61-214 A/T R/L

FUEL AND SOLENOID VALVE ASSY 8247-472005
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) B/P NOTES

THRUST CHAMBER 8247-470002
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) RADIOGRAPHIC INSPECTION
4) INSPECTION CHECKLISTS
A - 60-2 THROAT AREA CALCULATION
B - 60-8 GIMBAL BUSHING MEASUREMENTS
TEST PROCEDURE
1) QDTP DATA SHEET

OXIDIZER VALVE 8247-472050
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) B/P NOTES

FUEL VALVE 8247-472010
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) B/P NOTES

INJECTOR 8096-473001
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) RADIOGRAPHIC INSPECTION
4) INSPECTION CHECKLISTS
A - 62-429
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8096-928005 ACCEPTANCE PROCEDURE

MANIFOLD - TURBINE PUMP 8247-474015
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) RADIOGRAPHIC INSPECTION
4) INSPECTION CHECKLIST
A - 62-430 A/T
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8247-928205 A/T PROCEDURE

PILOT OPERATED SOLENOID VALVE 8247-472015
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) INSPECTION CHECKLISTS
A - 60-123 KIT INSPECTION
B - 60-126 ASSY. PROCEDURE
C - 60-339 CLEANING
TEST PROCEDURE
1) QDTP DATA SHEET
2) B/P NOTES

ORIFICE PLATE 8096-473002
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) INSPECTION CHECKLISTS
A - 60-4 DIMENSIONAL CHECKLIST
TEST PROCEDURE
NONE REQUIRED

INJECTOR - GAS GENERATOR 8247-474501
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) B/P NOTES

ORIFICE PLATE - GAS GENERATOR 8096-474502
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) INSPECTION CHECKLIST
A - 61-283 PERIODIC TOOL INSPECTION
TEST PROCEDURE
NONE REQUIRED

TURBINE PUMP ASSY 8247-474004
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) ASSEMBLY HISTORY SHEET 63-33
3) COMPONENT HISTORY CARD
4) INSPECTION CHECKLIST
A - 63-606 COMPONENT INSTALLATION
TEST PROCEDURE
1) 8247-928205 A/T PROCEDURE
2) I.C.L. 63-547

MOUNT ASSY. 8247-475209
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
NONE REQUIRED

TURBINE DRIVE ASSY 8247-474010
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) ASSEMBLY HISTORY SHEET 63-29
3) ASSEMBLY HISTORY SHEET 63-26
4) COMPONENT HISTORY CARD
5) INSPECTION CHECKLIST
A - 63-512 COMPONENT INSTALLATION
TEST PROCEDURE
1) 8247-928205 A/T PROCEDURE

ROTOR BALANCE ASSY 8096-474101
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) BALANCE ASSY. REPORT
4) BALANCE ASSY. HISTORICAL RECORD
TEST PROCEDURE
NONE REQUIRED

OX. BALANCE ASSY 8096-474301
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) BALANCE ASSY. REPORT
4) BALANCE ASSY. HISTORICAL RECORD
TEST PROCEDURE
NONE REQUIRED

FUEL BALANCE ASSY. 8096-474201
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
3) BALANCE ASSY. REPORT
4) BALANCE ASSY. HISTORICAL RECORD
TEST PROCEDURE
NONE REQUIRED

FILTERS - OX. AND FUEL (OSP) 8247-472045
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) B/P NOTES

START TANK ASSY - OX. (OSP) 8247-471201
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8247B471201 BOOK FORM DRAWING
3) 8247-928207 A/T PROCEDURE

FILL AND DRAIN CHECK VALVE - OX (OSP) 8247-472065
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8247B472065 BOOK FORM DRAWING

BLEED VALVE - OX. 8247-472075
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) B/P NOTES

GAS GENERATOR SOLENOID VALVE - OX. (OSP) 8247-472025
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8247B472025 BOOK FORM DRAWING

VENTURI ASSY - OX. 8247-472055
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) B/P NOTES

VENTURI - OX. (OSP) 8247-472056
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) B/P NOTES

DUAL CHECK VALVE - OX. (OSP) 8247-472035
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8247B472035 BOOK FORM DRAWING

START TANK ASSY - FUEL (OSP) 8247-471202
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8247B471202 BOOK FORM DRAWING
3) 8247-928207 A/T PROCEDURE

FILL AND DRAIN CHECK VALVE - FUEL (OSP) 8247-472070
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8247B472070 BOOK FORM DRAWING

BLEED VALVE - FUEL 8247-472080
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) B/P NOTES

GAS GENERATOR SOLENOID VALVE - FUEL (OSP) 8247-472020
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8247B472020 BOOK FORM DRAWING

VENTURI ASSY - FUEL 8247-472060
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) B/P NOTES

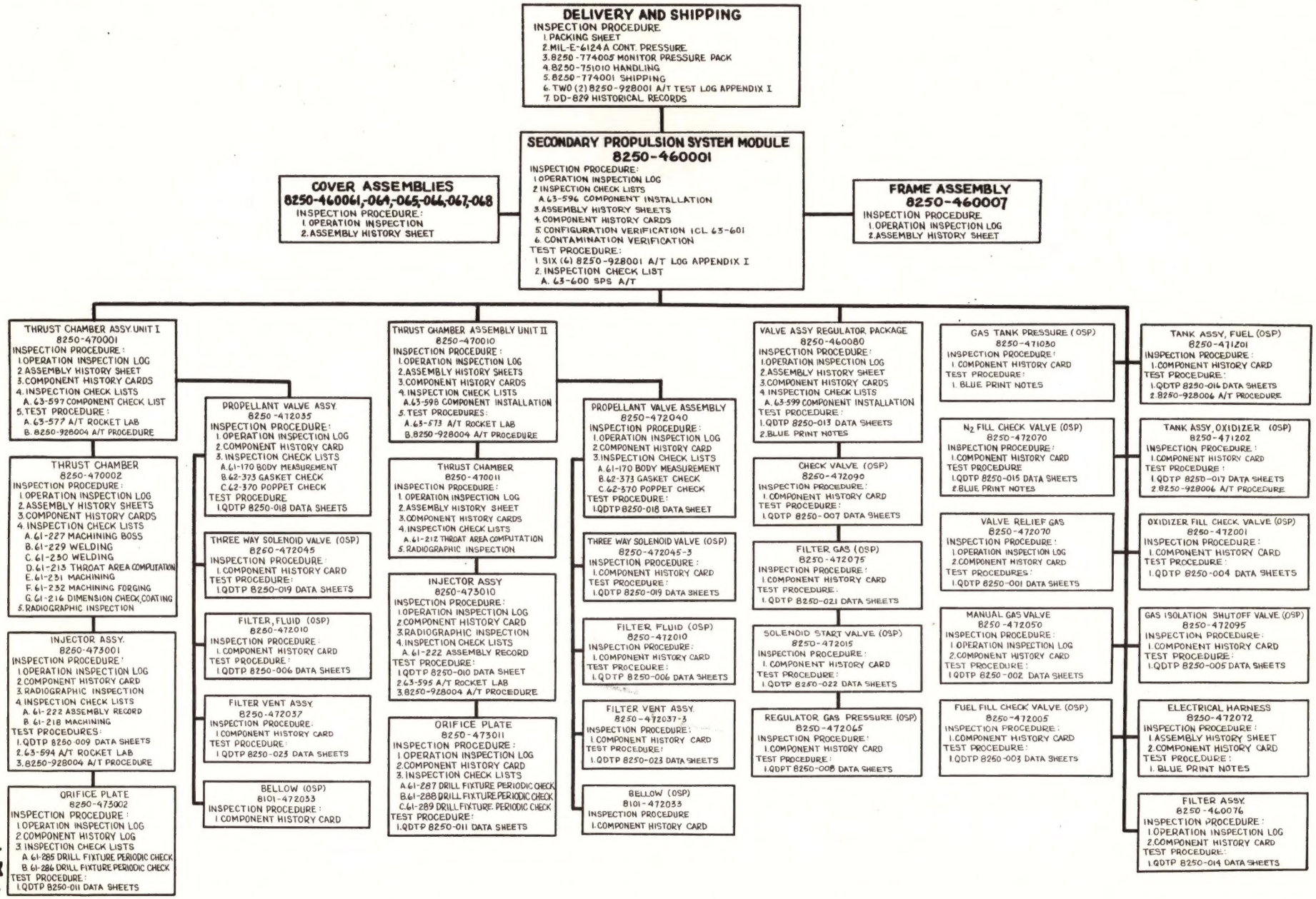
VENTURI - FUEL (OSP) 8247-472061
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) B/P NOTES

DUAL CHECK VALVE - FUEL (OSP) 8247-472040
INSPECTION PROCEDURE
1) OPERATION INSPECTION LOG
2) COMPONENT HISTORY CARD
TEST PROCEDURE
1) QDTP DATA SHEET
2) 8247B472040 BOOK FORM DRAWING

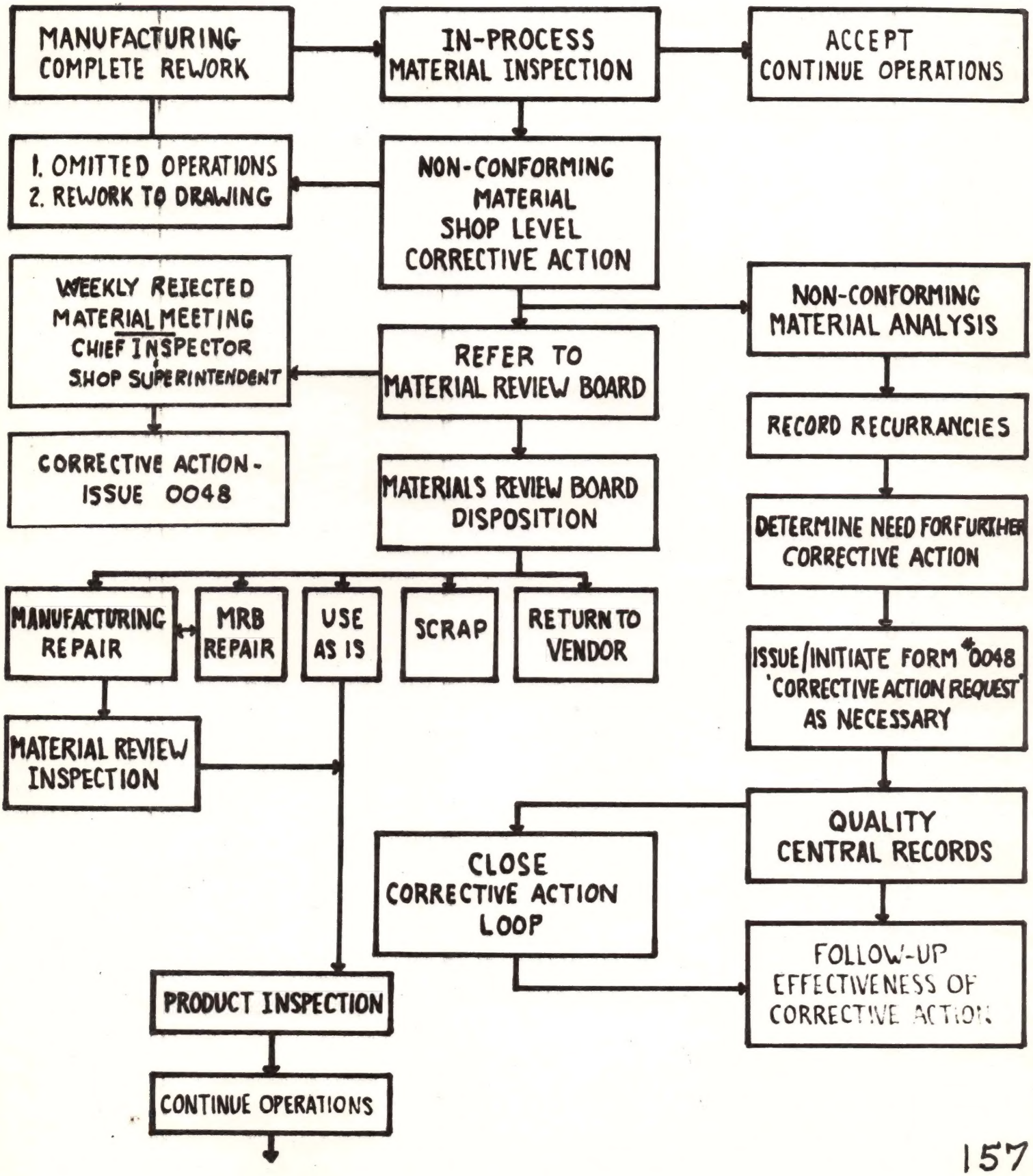
BELL AEROSYSTEMS COMPANY
QUALITY DEPARTMENT

INSPECTION AUDIT POINT PLAN FOR MODEL 8250 SECONDARY PROPULSION SYSTEM MODULE

DATE 12-5-64
APPROVAL G. T. Bailey



HANDLING OF NON-CONFORMING MATERIAL



QUALITY FLOW CHART

VENDOR/SUB-CONTRACTOR CONTROLS